National Oceanography Centre, Southampton

Cruise Report No. 19

RRS *Charles Darwin* Cruise 119C Leg B

13 AUG - 14 SEP 1999

White Zone (WhiZ) environmental survey:
seabed survey of the deep waters to the north
and west of Shetland

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2007

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ABSTRACT

This cruise formed part of the continuing Atlantic Margin Environmental Survey (AMES). The objectives of the cruise were: a) to complete TOBI sidescan sonar survey of the "White Zone", begun on RRS *Charles Darwin* cruise 119C Leg A; b) to carry out photographic surveys of the "White Zone" to ground truth the sidescan sonar imagery and provide an assessment of the seabed fauna; and c) to carry out seabed sampling to further ground truth the sidescan sonar imagery and generate samples for the future analysis of selected environmental parameters (hydrocarbons, elements, particle size). The cruise was undertaken in three phases: I) seabed photography and sampling of the southern "White Zone" area (Wyville Thomson Ridge and adjacent areas of the Faroe Bank Channel and Faroe-Shetland Channel) surveyed by TOBI during RRS *Charles Darwin* cruise 119C Leg A; II) TOBI survey of the central Faroe-Shetland Channel, Faroe Slope and an area north of Shetland; and III) seabed photography and sampling of the areas surveyed by TOBI during phase two. The survey encountered a very wide variety of seafloor environments, including areas of extremely dense gravel cover, areas of near complete cobble / rock / boulder cover, and a field of small barchan sand dunes on the floor (1,200m) of the Faroe Bank Channel. Two other notable TOBI features were also examined: 1. A new field of "*Darwin Mounds*", in the northern Rockall Trough, with associated colonies of the coral Lophelia pertusa and populations of the xenophyophore *Syringammina fragilissima*. 2. Localised areas of complex seabed topography (mud diapirs), in the area north of Shetland.

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KEYWORDS
AMES, Atlantic Margin environmental survey, benthic communities, barchans, box corer, *Charles Darwin*, continental slope, coral, Cruise 119C Leg B 1999, *Darwin Mounds*, Faroe Bank Channel, Faroe Plateau, Faroe-Shetland Channel, heavy metals, hydrocarbons, *Lophelia pertusa*, megacorer, NE Atlantic, North of Shetland, photography, Rockall Trough, seabed sediments, sidescan sonar, *Syringammina Fragilissima*, TOBI, videotape recording, WASP, West of Shetland, White Zone, Xenophyophores

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YOUNG, D	Research Vessel Services, SOC

2. SHIP'S PERSONNEL

LONG, G	Master
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MCGILL, I	Chief Engineer
GREENHORN, A	2nd Engineer
PHILIPS, C	3rd Engineer
COOPER, C	Electrical Engineer
HARRISON, M	Bo'sun
LEWIS, G	Bo'sun's Mate
PERKINS, J	Seaman
TUPPENEY, N	Seaman
TARRAN, J	Seaman
BAXTER, A	Senior Catering Manager
CONNELLY, D	Chef
ROBINSON, P	Steward
ORSBORN, J	Steward
MINGAY, G	Steward
WOOD, W	Motorman

3. ITINERARY

Sailed Govan	13 August 1999
Arrived survey area	15 August
Begin TOBI survey	24 August
End TOBI survey	5 September
Departed survey area	9 September
Docked Southampton	13 September 1999

4. OBJECTIVES

1. Complete TOBI sidescan sonar survey of the "White Zone" begun on RRS *Charles Darwin* cruise 119C leg A.

2. Carry out photographic surveys of the "White Zone" to ground truth the sidescan sonar imagery and provide an assessment of the seabed fauna.

3. Carry out seabed sampling to further ground truth the sidescan sonar imagery and generate samples for the future analysis of selected environmental parameters (hydrocarbons, elements, particle size).

5. NARRATIVE

5.1 Diary (see chart 1)

Wednesday 11 August.

PSO and some of the scientific part join the vessel. The bulk of the survey equipment having already been loaded aboard by the ship's crew. Preparations for sea begin

Thursday 12 August.

Preparations continue. PSO and RVS technician (Chris Hunter) interviewed by ISM auditor. Remainder of the scientific party arrive through the day.

Friday 13 August.

Preparations continue. Scientific party receive safety and familiarisation briefing from the Chief Officer. Vessel sails KGV Govan at 1200 (BST). Entire complement takes part in emergency muster drill and go to boat stations. Some slow progress between 1600-1900 as an engine room sensor is found to be faulty.

Saturday 14 August.

On passage to work site. Gear preparations continue. Science meeting held to outline the general objectives and work pattern of the cruise to the scientific party. Bathysnap system constructed and activated - first flash fire seen at 1410 (Z), second at 19:58 (Z). Ship's clocks are retarded by one hour to GMT/UTC.

Sunday 15 August.

Arrive at work area 0800. Deploy USBL hydrophone, 10 and 3.5 kHz fish and test USBL beacons to confirm that hydrophone is correctly orientated. Bathysnap mooring (55001#1) is deployed during this time. The 3.5 and 10 kHz systems are activated, both experience minor problems immediately. Power supply fails to the 3.5 kHz recorder and the printer for the 10 kHz fails with a jammed print cartridge. Both faults are quickly rectified with the vessel proceeding to the first waypoint of an echo-sounding run through the tail mound field target (Site A). Echo sounding confirms the presence of seabed mounds of a similar character to the '*Darwin Mounds*'. WASP is then deployed at Site A as station 55002#1. Bit of a slow start as we run over the wire. When corrected, WASP remains ahead of the vessel during the 'tow'. Tow goes well, although Mk7 camera appears to stop early. All video and an appropriate amount of film are found to have run on recovery. The early camera stop had resulted from the drive belt detaching - this is repaired and appears to work correctly in the laboratory. Video shows corals and xenophyophores as expected, though the ground does appear a little different to the '*Darwin Mounds*' sites previously studied (AFEN '98, RRS *Charles Darwin* cruise 112C).

Deploy Megacorer at Site A as station 55002#2, but this is quickly aborted as there is a problem with the bow thruster. Corer redeployed as 55002#3, a severe wire angle develops during this deployment, and the corer returns with only two short, bubbling, unusable cores.

Try again as 55003#3, and again a rather bad wire angle and the corer returns completely empty bar water. Give up on coring Site A and proceed to Site B. Echo-sound over the 'lump' target. It appears to be a 'south' facing scarp with no matching face on the 'north side. An unusual looking area of seabed (on the 3.5 kHz profiler) is noted at 60 00.3 N 07 09.7 W. Reposition to near the brow of the scarp and deploy WASP as station 55003#1. Tow appears to go well, with the Mk7 apparently operating throughout. Film and video run. Video shows rather rocky ground with variable but near complete cover with various mixtures of gravel, cobbles, rocks and boulders, having a well developed sponge fauna with a good number of mobile invertebrates, particularly cidarids and sea cucumbers and a good number of fish, particularly *Helicolenus.*

Monday 16 August.
Some problems are experienced with GPS display not updating, these are quickly rectified. Relocate to Site C, an area of lineations, and deploy the Megacorer as station 55004#1, it returns with 6/6 cores (though one is rather short), these are sampled for hydrocarbons, heavy metals and particle size. Proceed to start point of echo-sounding run to determine positions of bathymetric transect stations in the Faroe Bank Channel. Positions are determined for 500, 800, 1000 and 1200 m. Relocated to the FBC1200 site and deploy the Megacorer as station 55005#1. Recover 4 cores generating normal set of samples plus one retained as live material by S Suhr of Southampton Oceanography Centre for potential study of protozoa. Reposition to FBC1200 site and deploy WASP as 55005#2. Complete good run with video and film. Video shows a muddy sand environment dominated by high density populations of stalked sponges.

Relocate to FBC1000 site and again deploy WASP (station 55006#1). Good tow, video shows rather featureless ground with a fauna apparently overwhelmingly dominated by surface tube-dwelling polychaetes/crustaceans. First attempt at coring (55006#2) returns 0/6, with a little scrapping of gravel. Second attempt (55006#3) with only four tubes returns two good long (30 cm) cores that are used for hydrocarbon and heavy metal samples.

Relocate to site FBC800 and deploy WASP as station 55007#1 and run down hill through the 800 m contour. Full film run and 65 mins of video. Video shows presence of numerous very large rocks and boulders, dominated by clustered growths of tubular white sponges. Several nice shots of rays.

Tuesday 17 August.
Make two attempts to core site FBC800 with the Megacorer (55007#2 and #3), both return with 0/4 cores. Some opportunistic specimen collections are made.

Relocate to site FBC500 and again make two attempts with the Megacorer (55008#1 and #2); again both return 0/4 cores yielding only opportunistic specimen collection. Give up and head for Site T (ridge crest). First attempt with Megacorer (55009#1) gives 0/4 and a cracked tube. Try again with the box corer (55009#2) and get a good core, covered by a gravel / cobble pavement with some small epifauna. Sampled for hydrocarbons, heavy metals and particle size.

A selection of invertebrates also collected opportunistically.
Relocate to Site W (overflow / lineations) and deploy WASP as 55010#1. Apparently good tow. Video shows gravely sand bottom with variable quantities of cobbles, rocks and boulders. A close encrusting fauna (mainly sponges) present, but frequently not particularly well developed. Cidarids and sea cumbers dominant amongst the mobile invertebrates. Lineations on TOBI may reflect variations in the quantity of cobble / rock / boulder? Several rabbit fish observed. Deploy box corer at Site W (station 55010#2), it returns with a good sample of gravel / cobbles over sand, with mud / clay at the base of the core. Sampled for hydrocarbons, heavy metals and particle size. A selection of invertebrates also sampled opportunistically.

Proceed to an echo-sounding run (waypoints A and B) through the prospective location of Site E (large open iceberg ploughmark). Echo-sounding shows one major trough in an appropriate location, with smaller troughs beyond (around WP B). Relocate to attempt to take WASP into / through the main feature. WASP deployed at Site E as station 55011#1. Good tow over ground that does appear to vary from dense gravel cover to more rocky ground. Branched sponges common at start of run but encrusting fauna subsequently not particularly well developed. A cable or cables (? long-line) seen numerous times during the run. An interesting spot with a fair number of ling together.

Relocate to Site FBC500 and make three attempts with the box corer (55012#1-3) all return gushing water, containing rocks and or washed out sand only, and are consequently useless for sampling purposes. Deploy WASP at same site as 55012#4. Video appears to show a seabed showing surface expression of iceberg ploughmarking, with several transitions from rocky / bouldery ground to more open gravely ground; various massive sponges common, also a number of stone crabs.

Retract hydrophone in preparation for long (30 nm) steam to sites on opposite side of Faroe Bank Channel. Make for Site N1, on the contourite side of the N location.

Wednesday 18 August.
Arrive at N1 and redeploy the USBL hydrophone. Make two attempts with Megacorer (55013#1 and #2), both return with water only. Relocate to Site N2, here the Megacorer returns (55014#1) with 2/4 good cores, generating hydrocarbon and heavy metal samples, plus an opportunistic collection of two ophiuroids. Deploy WASP at N2 as station 55014#2 with the intention of doing a 30 min run, to split the tape with N1. WASP locks on to something in midwater while still 200 m off bottom (water mass interface?) Video shows a featureless seafloor of fine gravel over sand with very little obvious fauna, most notably a few large sea pens.

Relocate to N1 and deploy WASP as station 55015#1. Again the altimeter locks on in midwater, some 200 m above true bottom - possible bottom water layer / flow effect? Video shows a very different seafloor and fauna to that of N2; mainly a cobble / gravel pavement with a variable abundance of rocks to very large boulders. Fauna dominated by a variety of sponges

and numerous featherstars. Deploy box corer at N1 as station 55015#2. It returns a part washed out core from which a PSA sample is removed from a relatively intact area of core surface. A gravely sand, with two small pycnogonids and a few cerianthids and their tubes (a selection of invertebrates retained opportunistically).

Head off to echo-sound for a Site P location. No sign of lineations ("furrows / ledges"), though the scarp to the north is fairly dramatic, a rapid 100 m rise. Relocate to an area of lineation and deploy WASP at Site P as station 55016#1. Video shows ground very similar to Site N1, but no obvious indication of the nature of the lineations.

Retract USBL hydrophone and steam up West Shetland Slope to obtain positions for sites FSC1200 - FSC300. Wind up to a steady 30 knots on crossing the 300 m contour but seems suitable to work. Some difficulty in redeploying the USBL hydrophone. Deploy WASP in the vicinity of FSC300 as station 55017#1.

Thursday 19 August.
Recover WASP, video and film have run. The video shows iceberg ploughmark type seafloor with sand and some gravel in parts and rock and cobble aggregations in others. Very little obvious fauna, particularly sparse in terms of epifauna. Relocate to FSC500 and deploy box corer as station 55018#1. Returns with a part washed out core that is only sampled for particle size analysis. Substrate of coarse sand with gravel and some small cobbles. Work stopped at 04:00 in the increasing swell.

At c. 08:00 make back to FSC500 to assess the prospects of work. Still a little too windy. Return to FSC500 to assess weather at c. 17:00, wind now dropped to closer to 20 knots, though the swell is still significant. Deploy WASP as station 55018#2 with the intention of a 30 minute run. Complete the run and recover WASP. Sandy ground, with some gravel and rocks, limited epifauna (similar to AFEN '96 southern area west of Shetland).

Relocate to Site FSC800 for another short WASP. Deployed as 55019#1 and successfully completed giving 65 mins DV for FSC500 and 800 together. Video shows a muddy sand ground, though with an appreciable number of rocks and encrusting fauna. Cluster burrows (fairy rings = enteropneusts) common in open sediment areas.

Relocate to FSC1000 and deploy WASP yet again as 55020#1 for another 30 minute run. Prior to deployment, Mk7 camera interval changed from 10 to 15 seconds to ensure coverage for the last of four deployments on the same 30 m film load.

Friday 20 August.
Recover WASP, video shows sandy ground with no indication of ripples, abundant population of stalked sponges. Relocate to FSC1200, after an initial false start, with an incomplete switch on, WASP is deployed as station 55021#1. However, the false start has used up all the remaining film and some 20 minutes of video. Consequently, only 14 minutes of video are

obtained at this deployment. The available seabed footage shows an intriguing strongly rippled sandy seabed.

Proceed to the first position of a four waypoint echo-sounding run in the Site L area (mottled sidescan). Neither the 10 kHz nor 3.5 kHz reveal any specific targets, and Site L is established in the centre of the region. WASP is deployed as station 55022#1 for a standard run and returns 65 minutes of tape. The video shows the now familiar (muddy) sand bottom with dense populations of stalked sponges and frequent burrow clusters. There are no obvious changes in the seafloor that might correspond with the TOBI mottling. However, in the otherwise flat and featureless seafloor WASP does run over a small patch of rocks that might equate to a 'mottle'. Reposition on Site L and deploy the Megacorer as station 55022#2. It returns with four good cores that are used for HC, HM and PSA samples and the top of the remaining core is retained 'live' by S Suhr (SOC).

Relocate to Site J (Black Hole), and deploy WASP as station 55023#1. The sandy seabed does have an abundant population of stalked sponges but is differentiated from similar sites by abundant tubes (? sabellids). Reposition on Site J and deploy the Megacorer as station 55023#2. The corer returns with 3/4 cores and generates the standard set of samples. Relocate to site K and deploy WASP as station 5504#1. The half hour tow reveals very rocky ground with dense cover of brittlestars. Reposition on Site K and deploy the box corer as station 55024#2. It returns empty (not surprisingly given the video!).

Relocate to Site G1 (the 'overflow' channel) and deploy WASP as station 55025#1 for a 30 minute run. The ground varies from dense gravel to very rocky, with brittlestars again very abundant. Relocate to site G2, a second 'overflow' channel location, and deploy WASP as station 55026#1 for a 30 minute run. A cobbly / gravely pavement, with dense brittlestar cover over at least part of the run.

Saturday 21 August.
Relocate to Site V (on top of the Wyville Thomson Ridge) and deploy WASP as station 55027#1. Video shows a seabed of gravely sand with some patches of rocks / cobbles. Retract USBL probe and steam (20 nm) to FSC1200 to improve on the previously achieved WASP coverage. Re-deploy the USBL probe and deploy WASP as station 55028#1. Video again shows a very strongly rippled seafloor. Reposition on FSC1200 and deploy the box corer as station 55028#2. It comes back gushing water with just a little clayey lump left in the box and the spade seal rucked up.

Relocate to Site FSC1000 and deploy the Megacorer as station 55029#1. It returns with 5/6 good cores, three giving the standard sample set, a forth is frozen whole as archive, and the fifth is taken by S Suhr (SOC) for study of live meiobenthos.

Head to echo-sound through a patch of potential barchan dune targets (Site R1). Nothing particularly definitive is seen on the echo-sounder and WASP is deployed as station 55030#1

in the general vicinity of Site R1. The video shows a sandy bottom with gravel streaks and relatively little obvious fauna. WASP is recovered and a second echo-sounding run is made through another area of potential barchans. One minor feature is seen on the echo-sounder and WASP is deployed in the general vicinity of Site R2 as station 55031#1. The video again shows, sand streaked gravel with relatively little obvious fauna.

Relocate to Site Q (lineations) and deploy WASP as station 55032#1. Video shows rocky / cobbly ground with occasional areas of 100 % gravel cover. Recover WASP and set off for Site S

Sunday 22 August.
At around midnight the vessel is hove-to ti check GPS function as the GPS satellites 'roll-over' their week numbers. All being well with the navigation systems, continue towards Site S (channels). Deploy WASP as station 55033#1, the video shows very sandy ground akin to that of the AFEN '96 'Black Hole' contourite (West of Shetland).

Make for the TOBI launch position. The launch (as station 55034) goes smoothly and the vehicle appears to function. However, the USBL magnetic switch has been left in place and the vehicle is recovered to activate the beacon. During the final stage of recovery the outboard end of the umbilical is fouled by one of the recovery lines and the serving on the termination is forced back. The vehicle is redeployed, but the beacon still does not function. The vehicle is recovered to further investigate the problem.

Relocate to a 1,000 m site (X1) near to the TOBI start position and deploy WASP as station 55035#1. During the WASP deployment, the USBL beacon on WASP works well and the TOBI directional beacon is also tested by dunking, and works perfectly. The WASP video shows sandy ground with rocks and gravel.

Return to TOBI start position and deploy the vehicle as station 55036#1. The deployment is aborted when a short occurs. The short occurred at the outboard termination, i.e. where the serving sleeve had been pulled away and repaired after the first deployment. The short had also blown a power circuit in one of the deck units. The later was quickly fixed and the umbilical re-terminated by the recommended method rather than the poor-looking commercial termination.

After recovering the TOBI vehicle the vessel heads for site X1 to deploy the Megacorer as station 55037#1, it returns with only one short core which is discarded. Reposition on Site X1 and deploy the Megacorer as 55037#2. It returns with 4/4 good cores, though one is a little short, generating the standard set of samples.

Monday 23 August.
Relocate to Site X2 and deploy WASP as station 55038#1 for a 30 minute run. The video shows sandy ground with rocks and gravel very similar to that of Site X1. Relocate to Site X3

and again deploy WASP for a 30 minute run (station 55039#1). The video shows ground similar to the seafloor of Site X1 and X2, however, the fauna appears somewhat different.

The USBL hydrophone is retracted and *Darwin* steams to the TOBI launch position. The TOBI vehicle is launched at around 11:00, but the data received onboard appears to be noise only. During a break in the hauling in of the vehicle, the sidescan begins to work / the noise disappears. This effect can be recreated by hauling then stopping again, suggesting that the problem may lie in the swivel. The depressor is recovered and the swivel changed but noise problems continue and the vehicle is eventually recovered for further investigations.

Deck testing confirms that the first swivel deployed is defective but that the second swivel works well both under load and no load conditions. The remaining noise problem seems to be associated with the umbilical, which is found suspect at the inboard end on this occasion. Use of the second new umbilical is deemed unwise given the near immediate failure of the first and it is resolved to employ an emergency back-up umbilical system (a towing rope with a coaxial cable attached at intervals along its length).

While preparations are made for the third attempt at launching TOBI, the vessel is again employed overnight in sampling and photographic work. Relocate to Site X2 and deploy the Megacorer as station 55041#1. It returns with 5/6 good cores, the sixth having lost its top water through a large burrow. The cores are used to generate the usual set of samples, one core is frozen and one kept at -1 °C for live meiobenthos study.

Relocate to Site X3 and again deploy the Megacorer (station 55042#1). It returns with 6/6 cores, though one is short through slumping. The cores are used to generate the usual set of samples and one core is frozen as archive. The USBL hydrophone is retracted and *Darwin* steams to Site Y1.

Tuesday 24 August.
On arrival at Site Y1, the USBL hydrophone is redeployed and WASP is deployed as station 55043#1. The video shows a sandy bottom with rocks and gravel similar to Sites X1 to 3, and having a similar fauna to Sites X1 and 2.

Relocate to the TOBI start position and deploy TOBI on the emergency umbilical as station 55044#1. The vehicle appears to perform well and the TOBI survey commences. Complete survey legs 1-3.

Wednesday 25 August.
Continuing TOBI survey. Complete survey legs 4-8 and begin leg 9. USBL beacon returning only occasional useful data.

Thursday 26 August.
Continuing TOBI survey. After some ‘fiddling’ with the USBL deck unit, the beacon now

appears to be locking on well. Complete survey legs 9 and 10. About half way along leg 11 the bridge see a fishing float pulled into the wire astern of the ship.

Friday 27 August.
Continuing TOBI survey. Complete leg 11 and begin leg 12.

Saturday 28 August.
Continuing TOBI survey. Complete legs 12 and 13 and begin leg 14.

Sunday 29 August.
Continuing TOBI survey. Course deviation to avoid US naval vessel towing a submersible. (Near midnight lose c. 30 mins data when TOBI logging system fails on an unformatted MO disc). Complete legs 14 and 15 and begin leg 16.

Monday 30 August.
Continuing TOBI survey. Course deviation to avoid Russian research vessel towing five mile hydrophone streamer. Intended recovery of vehicle postponed in 30+ knots winds and rising seas. Commence hauling TOBI in at 15:00, with the wind much reduced and the seas dropping. TOBI safely on deck at 17:00. Head for Site FPS1800. Arrive at FPS1800 site to find that we can not work there or any of the other planned FPS stations as a result of Russian research vessel towing a five mile hydrophone array heading almost directly down the line. Relocate to an alternative FPS1800 site some 5 nm to the northeast. Deploy WASP as station 55045#1. Camera data requests stop shortly after reaching the bottom, assume camera drive belt has snapped and continue the tow for video only. Belt had snapped and no film had run. The 65 minutes of video show a uniform rather featureless sandy mud bottom with very little obvious fauna, but very numerous conical pit burrows.

Tuesday 31 August.
Relocate to Site FPS1500 and deploy WASP as station 55046#1 for a 30 minute run having repaired the drive belt. Film and video run; the latter shows a muddy sand bottom with substantial quantities of gravel and cobbles and the occasional boulder, having a fauna dominated by octocorals and pennatulids. Relocate to Site FPS1000 and again deploy WASP for a 30 minute run (station 55047#1). Recover WASP. Film and video run; the latter shows a muddy sand bottom with substantial quantities of gravel and cobbles and the occasional boulder, having a fauna dominated by brisingiids. Retract USBL hydrophone and steam for TOBI launch site at c. 62° 30.0’ N 01° 19.0’ W. Redeploy the USBL hydrophone and launch TOBI as station 55048#1 heading north on original leg 19 (having omitted part of leg 17, all of leg 18 and part of leg 19). Wind and sea increase but surf in reasonable comfort with the weather.

Wednesday 1 September.
Continuing TOBI survey. Complete partial leg 19. Unable to keep ship’s speed down with the following weather, come round to the southeast to make towards line 21. Pick up on line 21

and head south. Some damage to deck stowed equipment as we take a large wave over the starboard side. Weather abating somewhat.

Thursday 2 September.
Continuing TOBI survey. Weather and seas picking up again, making slow progress (1.5 knots) down line 21. Start having to put some west in the course. Finish line 21 early and head to the northeast to pick up on line 23. USBL hydrophone appears to have been dead all day.

Friday 3 September.
Continuing TOBI survey. Making to the north northeast, on revised line 22, to pick up line 23 northbound. Complete line 22 and begin line 23. USBL dead all day.

Saturday 4 September.
Continuing TOBI survey. Heading north bound on line 23. Complete line 23 and 24. Planned recovery of TOBI vehicle abandoned in high winds and seas. Turn on to line 25 (originally planned line 20 in reverse direction).

Sunday 5 September.
Continuing TOBI survey. On line 25 cross major feature, similar in appearance to that on line 19, having associated 150 m change in seabed depth. Decide to recover TOBI although wind and sea state are still rather marginal. Some additional wire is paid out prior to recovery to enable cleaning of the full length of wire used during TOBI deployments. TOBI recovered without incident. Make for Site NS1 (below TOBI feature of line 25) via two waypoints to potentially cross the same feature on a parallel track to first pass. And indeed cross a 140 m high scarp. Deploy WASP for half an hour at Site NS1 as station 55049#1. USBL system continues not to function. Mk7 camera stops after a few moments on the bottom. Recover WASP. Video shows relatively featureless, uniform creamy mud seafloor, dominated by sabellids. Retract USBL and keep it retracted. Reposition to Site NS1 and deploy the Megacore as station 55049#2. It returns with 4/8 cores, with three units together unfired, possibly having struck the bottom at an angle. Relocate to Site NS2, within the area of uneven terrain just upslope of the TOBI feature from line 25. Deploy WASP as station 55050#1, Mk7 fails in midwater.

Monday 6 September.
Recover WASP after half hour run. Video shows general seafloor similar to NS1, though with more tracks, but also occurrences of sculptured ‘clay’ boulders. Reposition on Site NS2 and deploy the Megacorer twice (55050#2 and #3), the first returning only one short core which leaked its top water via a large crack in the tube, the second with three good cores and one short core that was lost on deck. Sampled for hydrocarbons, heavy metals and particle size.

Steam for Site NS3, general 1500 m location, via an echo sounding waypoint to further investigate the scarp associated with the line 25 TOBI feature. Deploy WASP at Site NS3 as station 55051#1 for a one hour run. Video shows a rather featureless, uniform seafloor of

cream mud, having a very high density of brittlestars. Reposition on Site NS3 and deploy Megacore as station 55051#2. Returns with 5/8 cores that are sampled for hydrocarbons, heavy metals and particle size and one is retained live (S Suhr).

Relocate to Site NS4, the TOBI feature on line 19. Deploy WASP for a one hour run as station 55052#1. Video shows WASP crossing three minor scarps, generally having a 'scree' slope with broken sediment blocks above. Open sediment areas similar to NS3 but without the high density of ophiuroids. Reposition on Site NS4 and deploy the box corer as station 55052#2.

Tuesday 7 September.
Box core returns with a fair, if sloping, core, sampled for hydrocarbons, heavy metals and particle size, a subcore also frozen whole and a sample taken for TBT analysis (M Hartl, SOC). Relocate to Site FPN1, 'lumpy' ground of TOBI line 16 via four waypoints to echo sound the target area. Deploy WASP for a one hour run as station 55053#1. WASP track appeared to miss the seafloor features with a substantial set to the west. Video only useful in parts (approx. 20 mins) as the autofocus had been activated; however, the ground is clearly of the open burrow and asteroid track type, no obvious signs of 'block' features. Relocate to Site FPN1800, open sediment area 2 miles from FPN1, and deploy the Megacorer as station 55054#1, giving 4/8 cores that are sampled for hydrocarbons, heavy metals and particle size, and a sample taken for TBT analysis (M Hartl, SOC). Relocate to a new start point for a second attempt at WASPing the FPN1 site. Deploy WASP as station 55055#1. Video shows the now familiar open burrow and asteroid track ground, with dense ophiuroids for most of the tow, one possible area of rocks, and a single 'clay block' feature at end of run.

Relocate to Site FPN1400 and deploy the Megacorer as station 55056#1. Returns with 5/8 cores, though one lost in processing, generating samples for hydrocarbons, heavy metals, particle size and a live core is retained by S Suhr (SOC). Reposition on Site FPN1400 and deploy WASP for a half hour run as station 55056#2. Video shows uniform ground of muddy sand / sandy mud, with very numerous ophiuroids and plenty of sabellids. Also a fair number of rocks with octocorals and branched white sponges. Reposition to Site FPN1100 and again deploy WASP for a half hour run (station 55057#1). Video shows uniform ground of muddy sand / sandy mud with gravel and a good number of rocks. Large ophiuroids, some asteroids and sabellids. Better developed epifauna on the gravel and rocks, tubular sponges, octocorals and ascidians. Relocate to Site FPN1100 and deploy the Megacorer as station 55057#2, producing only 2/8 very short cores that are used for hydrocarbon and particle size samples

Reposition to Site FPN2, varied backscatter area on the apex of the Faroe Plateau. Deploy WASP as station 55058#1.

Wednesday 8 September.
Recover WASP, video shows muddy sand ground with plenty of gravel and cobbles with rocks and occasional boulders, active current flowing, brisingiids the dominant form. Relatively

uniform ground with some variation in gavel / cobble cover, though possibly one feature of rocks near start of tow. Steam at best speed for the Faroe Bank Channel in the hope of doing some more work in that area. By midday speed reduced to 3-5 knots in rather heavy weather. Continue to make only slow progress.

Thursday 9 September.
Still in heavy weather, making almost no progress. With no prospect of further work the vessel eventually leaves the survey area around 17:00 on passage to Southampton. Scientific party begin packing up. Clocks advanced one hour to BST overnight.

Friday 10 September.
Continuing on passage to Southampton. Eventually make it in to the northern Minch and the ship's speed is increased. At 08:30 (BST) the vessel heaves to and the 3.5 and 10 kHz tow fish are recovered. Cruise wash up meeting held with Master, Chief Officer, Technical Liaison Officer and Principal Scientist; there were no significant matters arising. Experience further heavy weather, reducing ship's speed to eight knots, for part of the day.

Saturday 11 September.
Continuing on passage to Southampton. Now making good speed.

Sunday 12 September.
Continuing on passage to Southampton.

Monday 13 September.
Cruise 119C leg B demobilises at Southampton.

Tuesday 14 September.
Vessel goes off hire at 0900.

5.2 Time allocation record

Cruise statistics		
Mobilisation, Govan	24 hrs	
Outward passage	44 hrs	
Survey	609 hrs	(23.4 days)
Inward passage	113 hrs	
Demobilisation, Southampton	7 hrs	
TOTAL	**797 hrs**	**(33.2 days)**

Survey statistics		
WASP and core work	293 hrs	48.1 %
TOBI survey	256 hrs	42.0 %
Failed TOBI deployments	21 hrs	3.4 %
Weather limited time	39 hrs	6.4 %
TOTAL	**609 hrs**	

5.3 Conclusions

Progress towards objectives:

1. The bulk of the planned TOBI survey was completed. Problems with the commercially produced TOBI umbilicals and weather conditions necessitated some changes to the tracks planned in the area north of Shetland.
2. WASP operations were largely very successful, encountering a wide range of seafloor types and faunas.
3. Seabed sampling operations met with less success. In particular, the rocky ground of the Wyville Thomson Ridge and the areas of dense gravel cover on the Faroe side of the Faroe Bank Channel proved highly resistant to sampling.

5.4 Acknowledgements

I would like to thank all of the ship's compliment for making this a successful and pleasant cruise. My apologies for the alternating periods of inactivity and frenetic work, it is in the nature of a mixed science cruise. We may not have achieved every objective, but that was not for want of effort; where we were beaten it was by circumstances beyond our control - not least by the autumnal weather!

6 SURVEY DESIGN

The cruise was undertaken in three phases: 1. seabed photography and sampling of the southern "White Zone" area surveyed by TOBI during RRS *Charles Darwin* cruise 119C leg A; 2. TOBI survey of the central Faroe-Shetland Channel, Faroe Slope and an area north of Shetland; and 3. seabed photography and sampling of the areas surveyed by TOBI during phase 2.

Phase one addressed a number of sites selected from the TOBI mosaic available following RRS *Charles Darwin* cruise 119C leg A, together with two sets of sites located systematically along bathymetric transects, as promulgated in advance of the present cruise. The sidescan sites investigated were as follows (see figure 1):

Site	Original designation
A	Tail mounds (as per "Darwin Mounds")
B	The lump / plug (? rock outcrop)
C	Fine, downslope lineations
E	Large, open iceberg ploughmark
G1	? Overflow channel
G2	? Overflow channel
J	'Very black hole' (contourite as per AFEN 1996 survey)
K	Upper ridge mottled area
L	Faroe Bank Channel mottled area
N1	Boundary contourite to lineations (lineation side)
N2	Boundary contourite to lineations (contourite side)
P	Larger furrow / lineations
Q	Smaller furrow / lineations
R1	Barchan dunes (and lineations)
R2	Barchan dunes (and lineations)
S	Debris flow channels
T	Ridge crest, iceberg ploughmark zone
V	Ridge crest, iceberg ploughmark zone
W	Possible overflow route / lineations

In addition, two bathymetric transects were also established (see figures 1 and 2). The first transect was led from near the apex of the Wyville Thomson Ridge down in to the Faroe Bank Channel (sites prefixed FBC). The second transect was led down from the continental margin in to the junction of the Faroe-Shetland Channel and the Faroe Bank Channel (sites prefixed FSC).

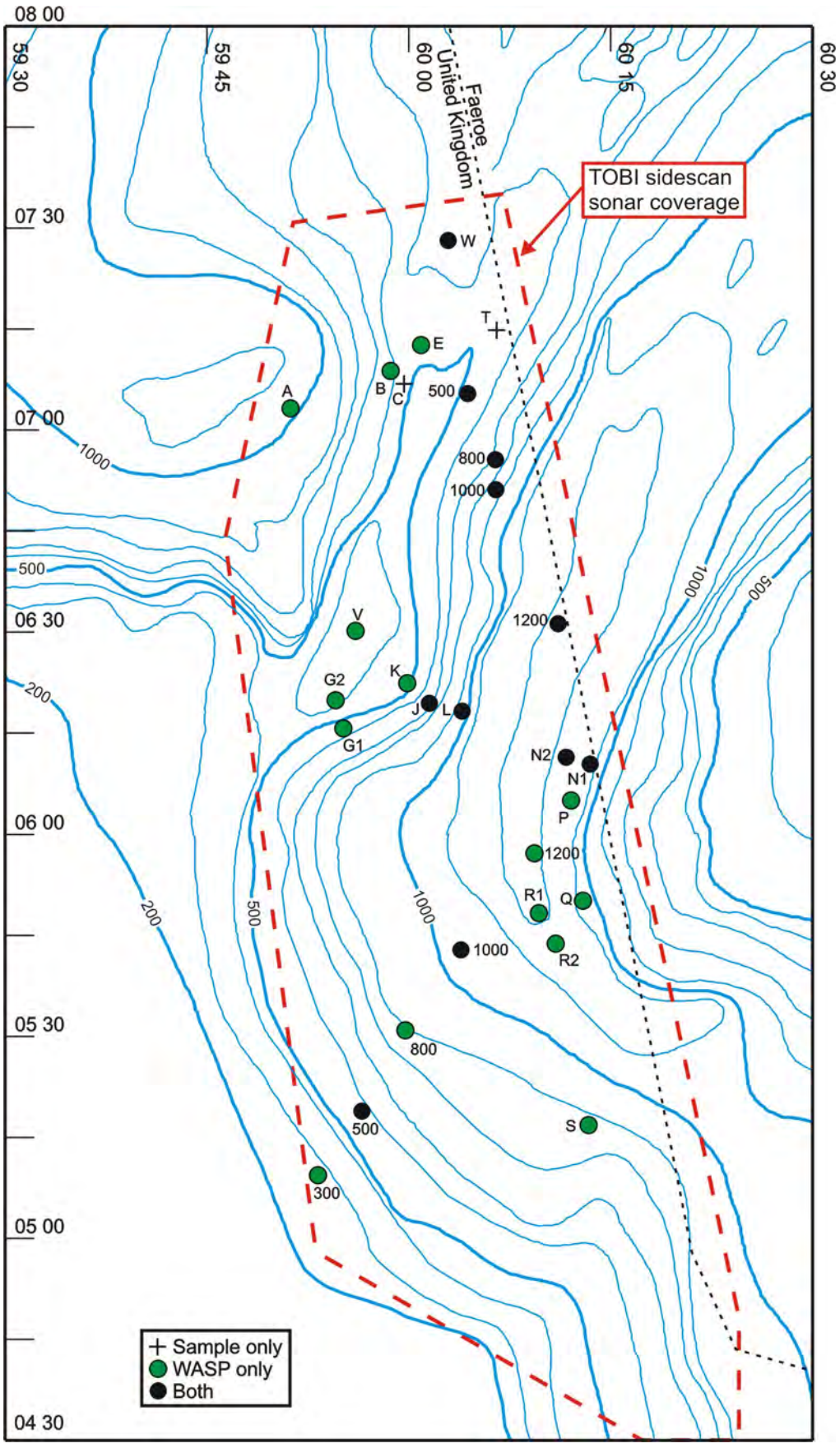

Figure 1. WASP and sampling sites occupied during phase one of RRS *Charles Darwin* cruise 119C leg B (Wyville Thomson Ridge and Faroe Bank Channel).

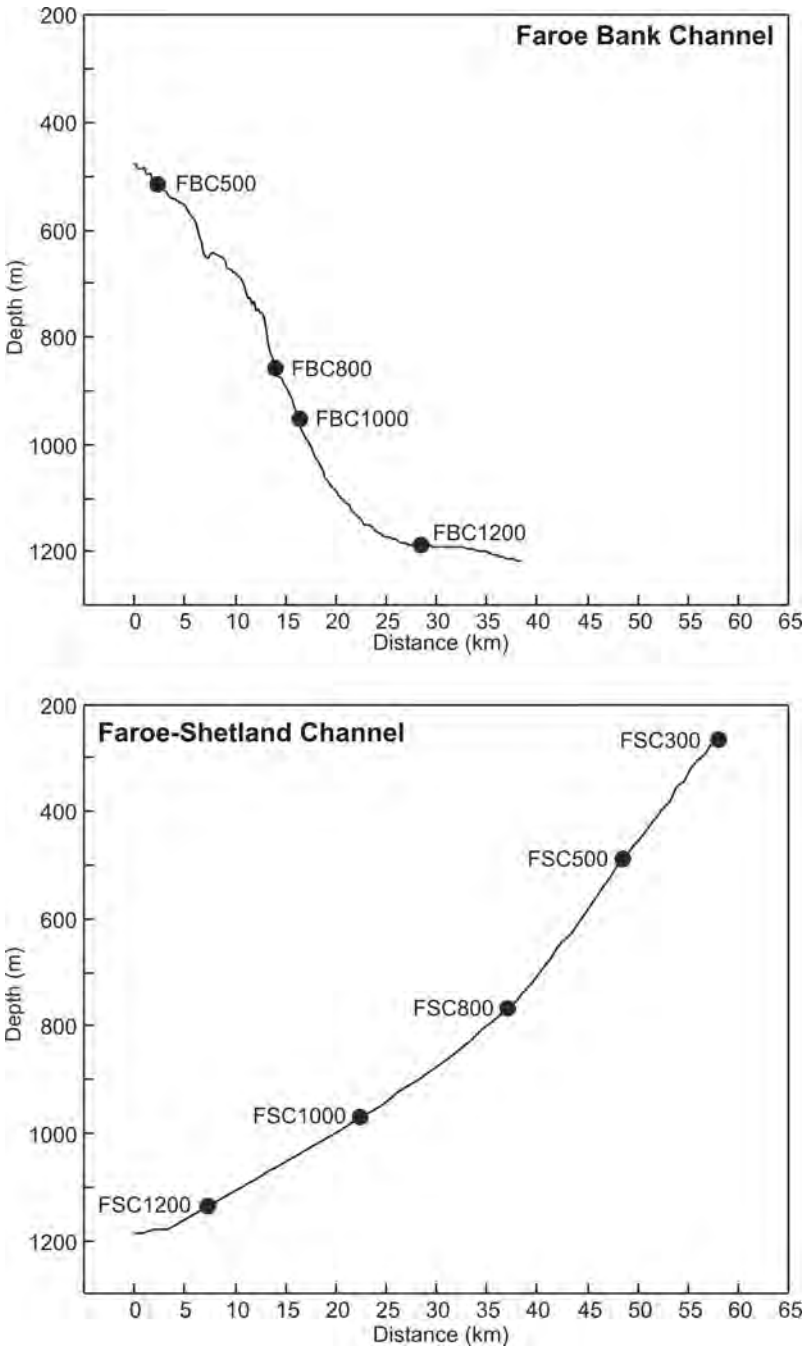

Figure 2. Transect stations occupied in the Faroe Bank Channel (FBC) and Faroe-Shetland Channel (FSC) during phase one of RRS *Charles Darwin* cruise 119C leg B.

Phase one of the survey was extended to carry out WASP and sampler deployments in the central Faroe-Shetland Channel while problems with the commercially supplied TOBI umbilicals were addressed. Four sites (X1 to X3 and Y1) were selected to give general coverage in this area (see figure 3).

Phase two began with a TOBI survey of the central Faroe-Shetland Channel and the northeast tip of the Faroe Plateau (figure 4). During the subsequent short period of TOBI service (i.e. recharging of USB beacon), three WASP deployments were undertaken on a transect on the southern side of the northeast tip of the Faroe Plateau (sites prefixed FPS; figure 5). The TOBI survey was then completed with operations in the north of Shetland area (figure 4).

Phase three completed the cruise with WASP and sampler deployments in the north of Shetland area and around the northeast tip of the Faroe Plateau (figure 5). Four sites were occupied north of Shetland:

NS1, a general deep-water (2,300 m) site
NS2, a site targeted on an area of complex topography imaged on TOBI line 25
NS3, a general 1,500 m site
NS4, a site targeted on an area of complex topography imaged on TOBI line 19.

A further five sites were occupied around the northeast tip of the Faroe Plateau:

FPN1, a site targeted on an area of complex topography imaged on TOBI line 16
FPN1100, a general 1,100 m site
FPN1400, a general 1,400 m site
FPN1800, a general 1,800 m site
FPN2, a site targeted on an area of varied acoustic backscatter.

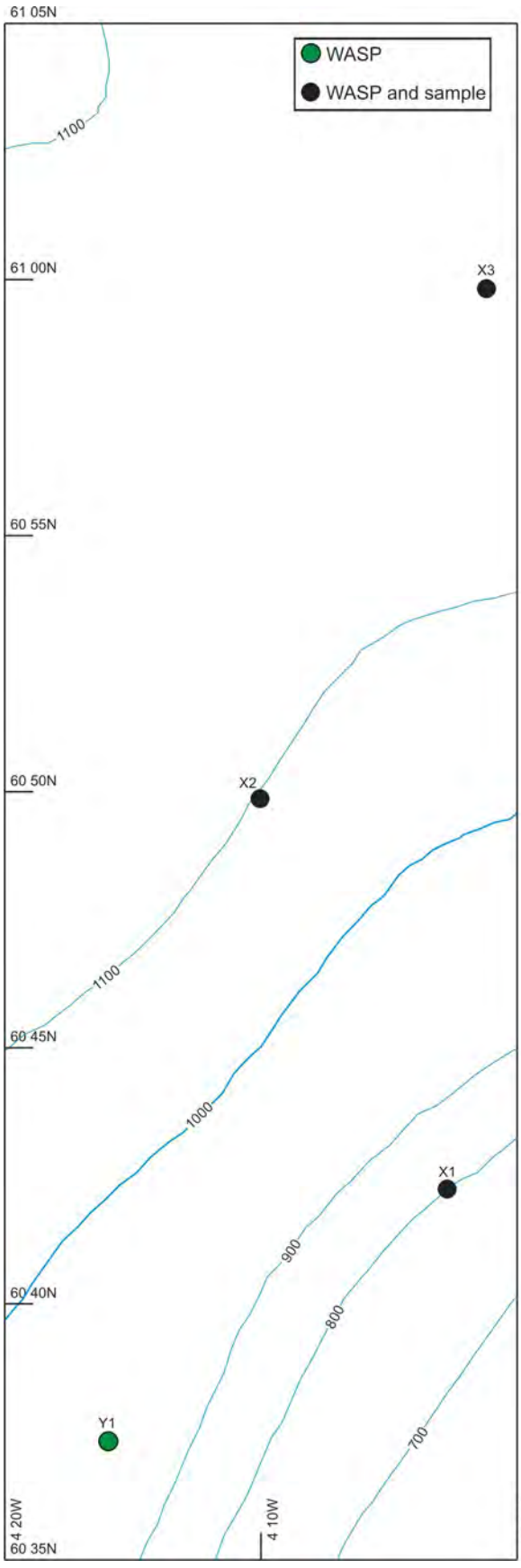

Figure 3. WASP and sampling sites occupied during RRS *Charles Darwin* cruise 119C leg B in the vicinity of the TOBI survey start position.

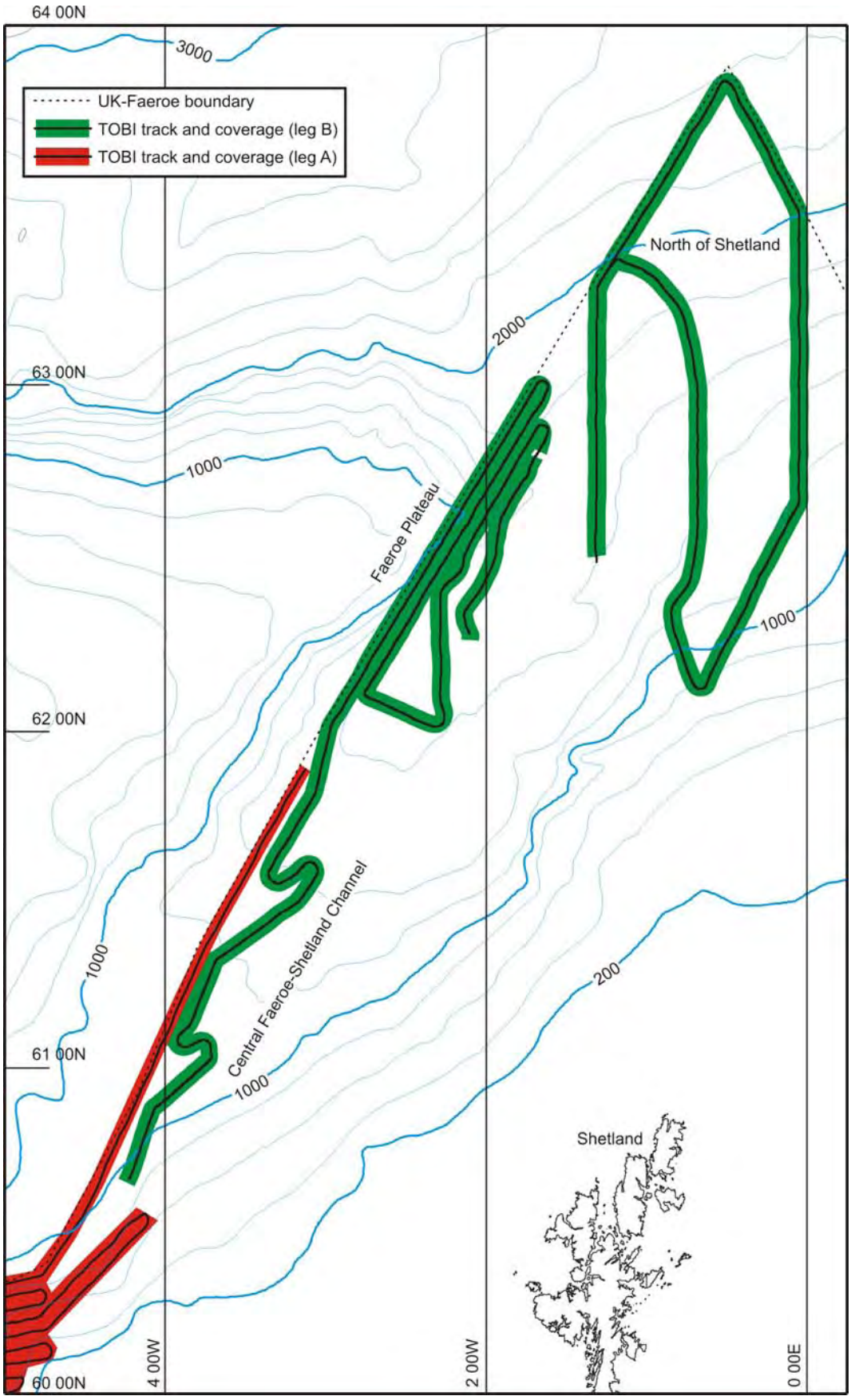

Figure 4. TOBI sidescan sonar coverage obtained during phase two of RRS *Charles Darwin* cruise 119C leg B.

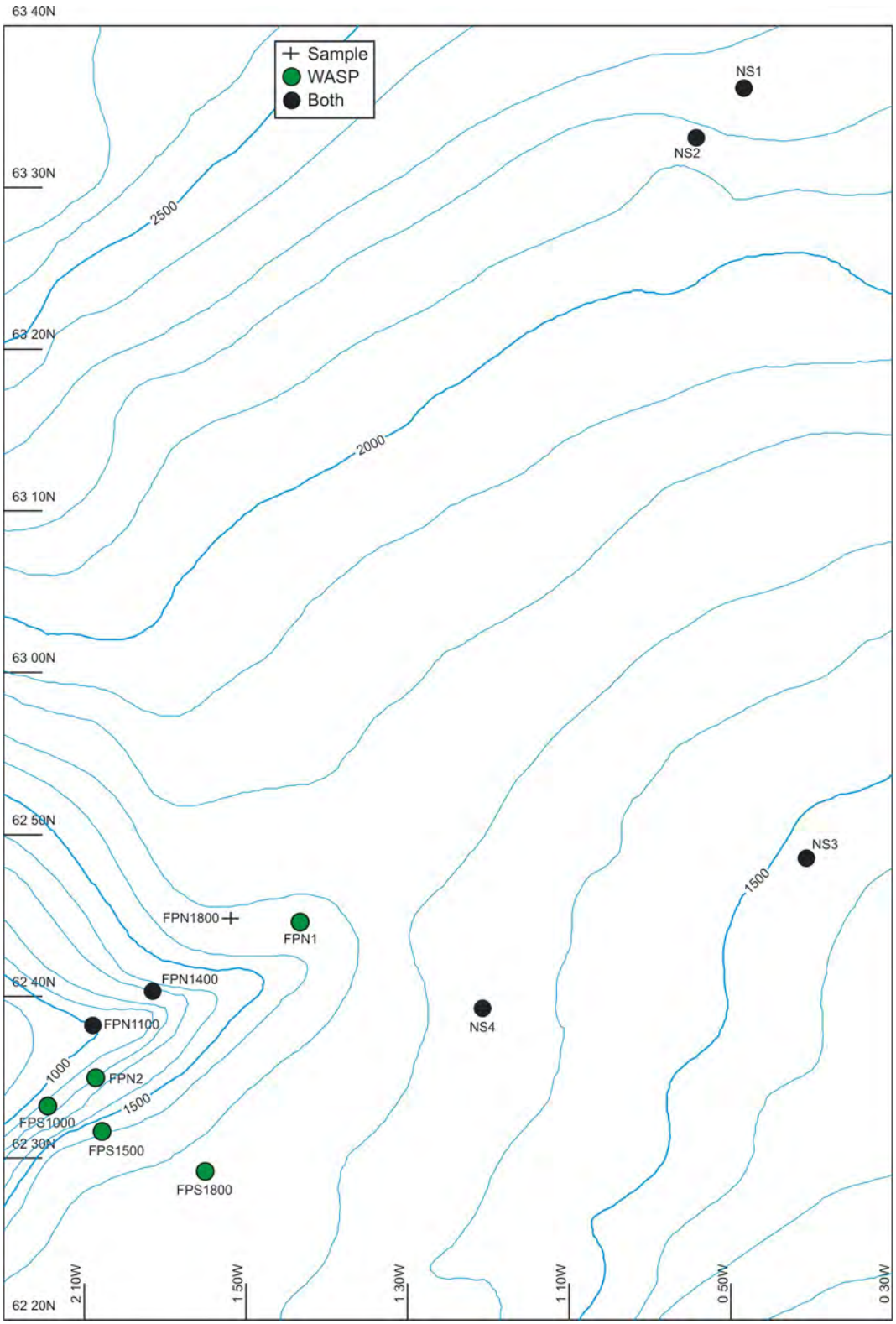

Figure 5. WASP and sampling sites occupied during phase three of RRS *Charles Darwin* cruise 119C leg B.

7. SAMPLING PROTOCOLS

7.1 Standard sampling protocol

Of necessity, variant protocols were followed for samples from the Megacorer and box corer.

Megacorer

On recovery of the corer, the function of each coring unit was checked and recorded. Core lengths were measured and recorded and any surface and profile features noted. Sample acceptance was based on the following criteria: cores > 10 cm in length; core surfaces essentially level; and, the sediment-water interface intact. The latter criterion was partly relaxed where localised disturbance had been caused by the dislodgement of gravel during core penetration. Acceptable cores were removed from the corer and transferred to the ship's laboratories for subsequent processing. In all cases, processing began with the careful removal of the supernatant water using gentle overflow, pump siphon and/or syringe as appropriate to the sediment type.

Hydrocarbon samples were processed by extruding the cores into a pre-cleaned metal collar and sectioning off the 0-2 cm horizon. The samples were preserved, in pre-cleaned aluminium pots, by freezing at -20 ºC.

Heavy metal samples were processed by extruding the cores into a pre-cleaned polycarbonate collar and sectioning off the 0-2 cm horizon. The samples were preserved, in pre-cleaned plastic pots, by freezing at -20 ºC.

Particle size samples were processed by extruding the cores into a polycarbonate collar and sectioning off the 0-5 cm horizon. The samples were preserved, in polythene bags, by freezing at -20 ºC.

Box corer

On recovery of the corer, its function was checked and recorded. If, on inspection through the top vents, the core appeared to be acceptable, the box and spade were dismounted and moved to a clear deck space. Sample acceptance was based on the following criteria: cores > 10 cm in length; core surfaces essentially level (excepting relief deemed to be natural); sediment surface covering the full cross-sectional area of the box (excepting limited, 5 cm or less, lateral compression); and, essentially clear supernatant water (limited resuspension, particularly following a recovery that crashed the box core off the ship's hull was deemed acceptable). The core was then drained of supernatant water using a pump siphon. Once drained, the surface of the core was examined and a record made of any surface features and / or fauna of note.

Hydrocarbon samples were collected using a pre-cleaned metal scoop to a nominal depth of 2 cm. The samples were preserved, in pre-cleaned aluminium pots, by freezing at -20 ºC.

Heavy metal samples were collected using a pre-cleaned plastic scoop to a nominal depth of 2

cm. The samples were preserved, in pre-cleaned plastic pots, by freezing at -20 ºC.

Particle size samples were collected using a plastic scoop to a nominal depth of 5 cm. The samples were preserved, in polythene bags, by freezing at -20 ºC.

7.2 Other sampling protocols

Frozen material

A variety of additional frozen material was collected during the course of the survey. Whole frozen cores, from the Megacorer, were prepared by extruding (by plunger from below) the bulk of the overlying water, leaving 2-3 cm, and inserting a top bung. The plunger was then withdrawn and the bottom of the core tube bunged. The core was then transferred and stored, in an upright position, in a -20°C freezer. When frozen solid (12-24 hours) the sediment core was extruded (after some warming in air or by running cold water over the core tube) on to dichloromethane-cleaned aluminium foil. A variety of invertebrates and some small sediment samples were also preserved by freezing at -20°C.

Live material

A number of cores were retained for live study of the meiobenthos. About 10 cm of sediment column and similar length of supernatant was extruded in to a polycarbonate tube. The tube was then bunged from below and stored in a larger container filled with supernatant water from other cores and stored at near-habitat temperature (typically 0°C).

8. SURVEY EQUIPMENT

8.1 10 kHz echo-sounder

A Simrad EA500 hydrographic echo-sounder was employed more-or-less continuously during the cruise. The system was operated through a 10 kHz precision echo sounder tow fish deployed from a davit portside for'ard. Echo-sounding results were recorded on an Hewlett Packard paintjet colour printer and detected depth was routinely logged to the vessel's central computer facility. The echo-sounder operated well throughout the cruise. The printer initially installed began repeatedly hanging part way into the cruise, it was replaced by a second printer that had a tendency to jam.

8.2 3.5 kHz profiler

An Institute of Oceanographic Sciences 3.5 kHz high resolution profiling system was employed more-or-less continuously during the cruise. The system was operated through a towed fish deployed from a davit starboard side aft. Profiling results were recorded on a Raytheon paper chart recorder. The profiler and chat recorder operated well throughout the cruise.

8.3 Acoustic tracking system

A Nautronix acoustic tracking system (ATS II) was employed during the cruise. The system uses ultra-short baseline acoustic navigation to located deployed equipment relative to the vessel. High powered omni-directional transponder beacons were mounted on the Megacorer, box corer and WASP. A high powered directional beacon was mounted on the TOBI vehicle. The ATS hydrophone was mounted on a retractable probe deployed through the ship's hull amidships on the midline. In operation, the ATS system was used to generate horizontal offsets (X and Y) from the vessel's midpoint to the deployed beacons. These offsets, together with the ship's heading and position, were used to estimate the deployed gear's position. ATS data were routinely logged to the vessel's central computer facility. The ATS system seemed to work well during the early stages of the cruise, requiring only the occasional reset. However, in the later stages of the cruise the system was only operational intermittently, erratically reporting various error. The system eventually ceased to operated and was turned off.

8.4 TOBI (towed ocean bottom instrument)

TOBI is a 30 kHz deep-tow side-scan sonar system capable of resolving targets down to two metres across. When towed above the seabed at an altitude of 300-400 metres, the swath is approximately three kilometres to each side of the vehicle. In order to ensure good vehicle stability, a two-body tow system is used. A 600 kg depressor weight fitted with an electro-mechanical swivel is towed on the end of the steel wire armoured conducting tow-cable. Fixed to the tail is a horizontal neutrally buoyant umbilical 200 metres in length; this carries the signals and power to and from the vehicle, through a single coaxial cable of the same construction as that in the armoured tow cable. In addition to the side-scan sonar, the vehicle carries a 7.5 kHz vertical sub-bottom profiler array, an Ultra Electronics tri-axial magnetometer and pitch and roll sensors, and an FSI conductivity, temperature and depth

sensor. During the present cruise a Nautronix directional acoustic navigation beacon was also fitted to the vehicle. Aboard ship, signals received from the vehicle are separated into port and starboard side-scan signals, profiler and digital data, and then demodulated and displayed on an operating console. The various data are digitally recorded on magneto-optical (MO) discs of 1.2 Megabyte capacity (= 27 hours operation). The MO discs are subsequently copied twice onto CD-ROM, one disc used for data processing the other is archived. In all 11 MO discs were recorded and these data transferred to CD-ROM. Towards the end of TOBI line 16, approximately one hour of data was lost at a change-over from one drive to another. This resulted from the second disc not having been properly formatted, causing the logging system to "hang". Following a system restart, it then took some time to diagnose and correct the problem. Otherwise all data were logged without incident and all were successfully transferred to the sonar processing system. The total number of hours of data logged was approximately 275 and the distance run 752 nm corresponding to an area surveyed of around 8,000 km².

TOBI was deployed six times during the cruise, the first four of these deployments being aborted shortly after launch. After extensive testing of the entire towing system it was determined that the umbilical was the cause of the various problems encountered and a jury-rigged umbilical was used for subsequent deployments. The replacement umbilical consisted of 90 metres of 28 mm plaited polyester rope, to which a 100 metre length of co-axial cable was loosely attached. The fifth and sixth TOBI deployments were carried out with this replacement umbilical. The problems with the TOBI umbilicals were a continuation of a series of failures relating to a batch manufactured earlier this year. Following the faults detected during RRS *Charles Darwin* cruise 119C leg A, efforts were made to rectify the problems. However, it is now clear that there are faults with the electrical cable as well as with the construction of the rope and its termination. A new source of umbilicals is now being sought.

8.5 Box core

A modified USNEL-type 0.25 m² spade box core, supplied by RVS, was used during the survey, it was rigged and deployed in the conventional manner.

8.6 Megacore

A Bowers & Connelly Megacorer equipped with twelve 10 cm internal diameter cores was used during the survey. Generally the corer was rigged and deployed in the conventional manner, with the number of coring units on the head varied to suit seabed conditions.

8.7 WASP

The SOC WASP vehicle (Wide-Angle Sea-bed Photography vehicle) is a 3 x 1 x 1 m protective framework housing video and 35 mm still cameras that can be towed up to 10m above the sea-bed. The 35 mm camera and flash are the Ocean Instrumentation Ltd Mk 7 camera and 1200 Joule flash, which have a capacity of over 800 full frame pictures. The video camera is a Sony digital camera, recommended for near broadcast quality work by the BBC. It takes a standard 65 minute miniDV tape. Two 250-Watt Deep Sea Power and Light Ltd video lights provide sufficient illumination when the vehicle is flown at its normal operating altitude

(for biological survey work) of 3-4 m. Vehicle altitude is measured with a Simrad Mesotech 808-B altimeter, which has a nominal range of 150 m, although WASP only uses measurements of less than 100 m.

Communications with the operator is via the SOC-designed Acoustic Command and Monitoring System (ACMS). The ACMS monitor on the vehicle relays parameters using 10 kHz pulse-position coding, which for WASP comprises pressure (depth), altitude and camera operation indicator. The signals are received through the ship's echo-sounder fish, and displayed on an SOC waterfall display. This can receive readable signals at ranges of 13,000 m, although it is usually necessary to disable the main echo-sounder and the 3.5 kHz profiler in order to render the display legible. The ACMS monitor also controls the cameras, automatically switching them on when the vehicle is between 1-10 m above the sea-bed. Power is from a total of three Deep Sea Power and Light Ltd 24 V lead-acid batteries. The vehicle is drift-towed at approximately 0.5 knot, depending on the bottom current and surface conditions. It is towed directly, from a top bridle, and is not de-coupled from the ship's motion. Working in conditions up to a sea-state 4 is possible, beyond which it can be dangerous to deploy and recover the vehicle. The ability to fly the vehicle at its operating altitude is controlled by the unevenness of the topography and the ability of the bridge officers to maintain a steady drift without excessive use of propeller or bow-thruster. The latter was rarely a factor; but the rugged terrain on several deployments resulted in contacts with the sea-bed, none of which caused any damage to the vehicle.

For a successful deployment the ACMS subsystems: monitor, pressure sensor and altimeter, must function correctly, and no problems were experienced with them. The altimeter always locked on to the sea-bed at its highest displayed range of 100 m. The monitor switches the two cameras independently; the 35mm camera then controls the flash, and the control subsystems inside the video camera's pressure housing control the video lights. Failure of one camera or its lights does not affect the other.

The 35 mm camera experienced one failure at the end of the third deployment, when the main drive belt partially snapped. This is a fitted-for-life component and no suitable spare was available. It was repaired, a repair which held until the end of 30th deployment when the belt snapped entirely. Subsequent repairs were less robust and on several deployments the repair failed at the start of the run, resulting in a loss of 35 mm coverage. The video camera suffered only two failures, both due to operator error. The first was on a 30 minute deployment, and it resulted in 15 minutes of the film being run in mid-water. The remainder of the film was shot at the working altitude. The second failure occurred when the auto-focus was accidentally switched on. The video frequently cannot keep track of the sea-bed in this mode and only 20 minutes of useful footage were obtained during the one hour run. In addition to live display on the Waterfall system, WASP telemetry was also printed out via a Waverley thermal linescan recorder. The recorder worked well through out the cruise and good records of all WASP deployments were obtained.

9. PRELIMINARY OBSERVATIONS

A first assessment of the direct seafloor investigations undertaken during the present cruise is given in Appendix I. The survey encountered a very wide variety of seafloor environments:

- *Near complete cobble / rock / boulder cover, often carpeted by featherstars (e.g. site G1)*
- *Extremely dense gravel cover again with abundant featherstars (e.g. site P)*
- *Barchan dunes with little obvious fauna (site FSC1200)*
- *Open sandy ground with very abundant stalked sponge populations (e.g. site FBC1200)*
- *Featureless muddy ground, often carpeted by brittlestars (e.g. site NS3)*

Two notable TOBI features were also examined:

1. A new field of 'tailed' mounds adjacent to the *Darwin Mounds* discovered on the AFEN '98 survey, with associated colonies of the coral *Lophelia pertusa* and populations of the giant protozoan *Syringammina fragilissima*.

2. Localised areas of complex topography, in the otherwise open sediment areas north of Shetland and the Faroe Plateau (e.g. sites NS2, NS4 and FPN1). WASP deployments in these areas should quite spectacular, fractured sediment blocks with gullies and scree slopes. These areas do not appear to support any 'unusual' fauna, though the presence of rocks does permit the development of an encrusting epifauna.

It is notable that a number of the sites examined in the course of the present cruise proved to be difficult, if not impossible, to sample. This is important to note for any future operations in this area. It may be that a number of these areas will never be amenable to direct seabed sampling and, therefore, that any future environmental assessment and / or monitoring will need to be conducted by visual methods only.

10. SAMPLE AND DATA CATALOGUE

10.1 Acoustic systems

Depth data from the 10 kHz echo-sounder was logged to the ship's central computer system and was archived to CD-ROM (held at SOC). A printed record was also maintained, which also indicates returning signal strength. The record (held at SOC) is in eleven sections as indicated in the table below:

Roll No.	Start		End	
	Day	Time	Day	Time
1	15/08/99	09:20	19/08/99	13:30
2	19/08/99	13:35	21/08/99	09:45
3	21/08/99	11:05	24/08/99	06:55
4	24/08/99	07:00	27/08/99	22:15
5	27/08/99	22:25	29/08/99	09:15
6	29/08/99	09:20	29/08/99	18:25
7	29/08/99	18:30	02/09/99	14:45
8	03/09/99	08:35	04/09/99	16:10
9	04/09/99	16:30	05/09/99	04:35
10	05/09/99	07:40	06/09/99	12:00
11	06/09/99	12:05	09/09/99	00:20

The 3.5 kHz profiler output was only recorder on paper. The record (held at SOC) is in 18 sections as indicated in the table below:

Roll No.	Start		End	
	Day	Time	Day	Time
1	15/08/99	10:15	16/08/99	12:00
2	16/08/99	12:04	18/08/99	00:00
3	18/08/99	00:03	20/08/99	05:56
4	20/08/99	06:13	24/08/99	23:56
5	25/08/99	00:00	25/08/99	23:55
6	26/08/99	00:00	27/08/99	11:37
7	27/08/99	11:40	28/08/99	00:00
8	28/08/99	00:08	28/08/99	23:56
9	28/08/99	23:59	30/08/99	00:00
10	30/08/99	00:02	31/08/99	23:54
11	01/09/99	00:00	01/09/99	23:55
12	01/09/99	23:58	02/09/99	23:54
13	02/09/99	23:57	03/09/99	23:54
14	03/09/99	23:57	04/09/99	07:36
15	04/09/99	08:10	04/09/99	23:59
16	05/09/99	00:01	06/09/99	12:07
17	06/09/99	12:10	07/09/99	23:36
18	07/09/99	23:38	09/09/99	12:30

The 30 kHz sidescan sonar data from the TOBI (towed ocean bottom instrument) vehicle was archived to magneto-optical discs (held at SOC). The following table summarises the TOBI deployments, note that only deployments 5 and 6 yielded data:

Deployment	Date	Time	Line	Distance run (nm)	Data discs	Comments
1	22/08/99	08:05	-	-	-	ATS beacon not on
	22/08/99	10:05				Damage to umbilical
2	22/08/99	10:32	-	-	-	Noise on sidescan
	22/08/99	11:47				No ATS function
3	22/08/99	18:58	-	-	-	Short on umbilical
	22/08/99	20:04				
4	23/08/99	10:41	-	-	-	Noise on sidescan
	23/08/99	15:31				
5	24/08/99	08:30	1 -	415	1 - 6	Jury-rig umbilical
	30/08/99	16:50	16		and 20	(1 hour data loss)
6	31/08/99	08:45	19 -	347	6a -	Jury-rig umbilical
	05/09/99	12:10	25		11	

10.2 Seabed samples

The seabed sampling programme principally aimed to collect samples for the subsequent analysis of hydrocarbons (HC), heavy metals (HM) and particle size (PSA). The primary samples retained (held at SOC), together with additional samples collected on an opportunistic basis are detailed in the table below:

Station	Site	Gear	HC	HM	PSA	Other samples
55004#1	Site C	MEGA06	Y	Y	Y	
55005#1	FBC1200	MEGA06	Y	Y	Y	Live core
55006#3	FBC1000	MEGA04	Y	Y	-	
55007#2	FBC800	MEGA04	-	-	-	Selection of invertebrates
55007#3	FBC800	MEGA04	-	-	-	Selection of invertebrates
55008#1	FBC500	MEGA08	-	-	-	Selection of invertebrates
55009#2	Site T	BOX CORE	Y	Y	Y	Selection of invertebrates
55010#2	Site W	BOX CORE	Y	Y	Y	Selection of invertebrates
55014#1	Site N2	MEGA04	Y	Y	-	Selection of invertebrates
55015#2	Site N1	BOX CORE	-	-	Y	Selection of invertebrates
55018#1	FSC500	BOX CORE	-	-	Y	
55022#2	Site L	MEGA04	Y	Y	Y	Live core
55023#2	Site J	MEGA04	Y	Y	Y	
55029#1	FSC1000	MEGA06	Y	Y	Y	Archive frozen core, live core
55037#2	Site X1	MEGA04	Y	Y	Y	
55041#1	Site X2	MEGA06	Y	Y	Y	Archive frozen core, live core
55042#1	Site X3	MEGA06	Y	Y	Y	Archive frozen core
55049#2	Site NS1	MEGA08	Y	Y	Y	Live core
55050#3	Site NS2	MEGA06	Y	Y	Y	
55051#2	Site NS3	MEGA08	Y	Y	Y	Live core
55052#2	Site NS4	BOX CORE	Y	Y	Y	Frozen subcore, TBT
55054#1	FPN1800	MEGA08	Y	Y	Y	TBT
55056#1	FPN1400	MEGA08	Y	Y	Y	Live core, selected invertebrates
55057#2	FPN1100	MEGA08	Y	-	Y	

10.3 Film and video footage

The colour film and digital video footage obtained (held at SOC) from deployments of the WASP vehicle are detailed in the table below:

Station	Site	Video	Film
55002#1	Site A	60 mins	15 m
55003#1	Site B	60 mins	15 m
55005#2	FBC1200	60 mins	15 m
55006#1	FBC1000	60 mins	15 m
55007#1	FBC800	60 mins	15 m
55010#1	Site W	60 mins	15 m
55011#1	Site E	60 mins	15 m
55012#4	FBC500	60 mins	15 m
55014#2	Site N2	30 mins	7 m
55015#1	Site N1	30 mins	7 m
55016#1	Site P	60 mins	15 m
55017#1	FSC300	60 mins	15 m
55018#2	FSC500	30 mins	7 m
55019#1	FSC800	30 mins	7 m
55020#1	FSC1000	30 mins	7 m
55021#1	FSC1200	15 mins	4 m
55022#1	Site L	60 mins	15 m
55023#1	Site J	30 mins	7 m
55024#1	Site K	30 mins	7 m
55025#1	Site G1	30 mins	7 m
55026#1	Site G2	30 mins	7 m
55027#1	Site V	30 mins	7 m
55028#1	FSC1200	30 mins	7 m
55030#1	Site R1	30 mins	7 m
55031#1	Site R2	30 mins	7 m
55032#1	Site Q	30 mins	7 m
55033#1	Site S	30 mins	7 m
55035#1	Site X1	60 mins	15 m
55038#1	Site X2	30 mins	7 m
55039#1	Site X3	30 mins	7 m
55043#1	Site Y1	60 mins	15 m
55045#1	FPS1800	60 mins	-
55046#1	FPS1500	30 mins	7 m
55047#1	FPS1000	30 mins	7 m
55049#1	Site NS1	30 mins	-
55050#1	Site NS2	30 mins	-
55051#1	Site NS3	60 mins	15 m
55052#1	Site NS4	60 mins	15 m
55053#1	Site FPN1	20 mins	15 m
55055#1	Site FPN1	60 mins	15 m
55056#2	FPN1400	30 mins	7 m
55057#1	FPN1100	30 mins	7 m
55058#1	FPN2	60 mins	15 m

11 STATION LIST

11.1 Station data

The following listing details basic station information and the primary survey samples collected. Further information is given in section 11.2, which provides a comment on each deployment and lists other samples collected.

Station Station and series number. The first five digits are the station number, which is separated from the series number by the hash (#) mark. The station number increments by one each time the vessel locates to another nominal site, regardless of whether that site has been sampled previously. The series number increments by one for each deployment made at a station.

Site Site name. The site name identifies a particular nominal survey location. Site names are unique within the cruise but do not uniquely identify particular deployments.

Date Date on which deployment was made (note that towed gear deployments may span two dates).

Time The time or times given relate to sample / data collection. In the case of cores the time given is that of bottom contact. In the case of towed gears (WASP and TOBI) the times reflect the duration of near- or on-bottom operations. All times given are UTC / GMT.

Depth The depth or depths given relate to sample / data collection. In the case of cores the depth given is that below the vessel at the time of bottom contact. In the case of towed gears (WASP) the depths reflect the range covered during the time of near- or on-bottoms operations. For WASP these are the range of depths covered below the vessel between the times given. All depths given are in corrected metres.

Sounding Mean sounding. In the case of cores the mean sounding given is the same as depth. However, in the case of towed gears (WASP) the mean sounding is the average depth covered during the times given (below the vessel in the case of WASP). All soundings given are in corrected metres.

Gear Gear deployed.

BSNAP	Moored time-lapse camera system
BOX CORE	USNEL-type spade box corer
MEGAxx	Megacorer with xx core units fitted
TOBI	Sidescan sonar vehicle (Towed Ocean Bottom Instrument)
WASP	Wide-Angle Seabed Photography vehicle with video and still cameras fitted

Nav. Navigation type: SHIP = ship's position; GEAR = deployed gear's position.

Position Sample position / track. In the case of cores, the position given is that of the vessel or gear at the time of bottom contact. In the case of WASP, the positions given are the start and end points of the track of near-bottom operations. Consult the corresponding deployment track chart in section 12 for details of individual WASP tows. All positions are given in degrees and decimal minutes based on the WGS84 datum.

HC Hydrocarbon. Y = sample for hydrocarbon analysis collected (- = no sample collected).

HM Heavy metals. Y = sample for elemental analysis collected (- = no sample collected).

PS Particle size. Y = sample for particle size analysis collected (- = no sample collected).

Station	Site	Date	Time	Depth	Mean	Gear	Nav.	Position		HC	HM	PS
55001#1	DMounds	15/08	08:16	902	902	BSNAP	SHIP	59 48.90N	007 26.30W	-	-	-
55002#1	Site A	15/08	13:58	1057	1050	WASP	SHIP	59 51.40N	007 03.70W	-	-	-
		15/08	14:55	1032				59 50.90N	007 02.10W			
55002#2	Site A	15/08	16:35	1057	1060	MEGA06	GEAR	59 50.13N	007 05.13W	-	-	-
55002#3	Site A	15/08	17:53	1072	1074	MEGA06	GEAR	59 50.13N	007 05.30W	-	-	-
55002#4	Site A	15/08	19:52	1061	1048	MEGA06	GEAR	59 51.05N	007 05.83W	-	-	-
55003#1	Site B	15/08	23:25	582	562	WASP	GEAR	59 58.72N	007 08.99W	-	-	-
		16/08	00:30	563				59 58.58N	007 08.60W			
55004#1	Site C	16/08	01:41	525	518	MEGA06	SHIP	59 59.17N	007 06.76W	Y	Y	Y
55005#1	FBC1200	16/08	08:29	1184	1184	MEGA06	SHIP	60 10.39N	006 33.55W	Y	Y	Y
55005#2	FBC1200	16/08	10:36	1191	1185	WASP	SHIP	60 10.86N	006 32.57W	-	-	-
		16/08	11:40	1156				60 11.33N	006 30.26W			
55006#1	FBC1000	16/08	15:46	942	953	WASP	GEAR	60 06.26N	006 51.50W	-	-	-
		16/08	16:52	967				60 06.67N	006 50.79W			
55006#2	FBC1000	16/08	18:18	1015	1015	MEGA06	GEAR	60 07.25N	006 52.33W	-	-	-
55006#3	FBC1000	16/08	19:42	1019	1019	MEGA04	SHIP	60 07.19N	006 50.78W	Y	Y	-
55007#1	FBC800	16/08	22:18	883	858	WASP	SHIP	60 06.30N	006 56.58W	-	-	-
		16/08	23:25	834				60 06.57N	006 54.63W			
55007#2	FBC800	17/08	01:29	799	799	MEGA04	GEAR	60 05.84N	006 55.72W	-	-	-
55007#3	FBC800	17/08	03:00	736	736	MEGA04	GEAR	60 05.83N	006 56.88W	-	-	-
55008#1	FBC500	17/08	05:19	483	483	MEGA08	GEAR	60 04.28N	007 09.36W	-	-	-
55008#2	FBC500	17/08	06:19	502	502	MEGA04	GEAR	60 04.30N	007 08.79W	-	-	-
55009#1	Site T	17/08	07:45	533	533	MEGA04	GEAR	60 06.87N	007 15.17W	-	-	-

Station	Site	Date	Time	Depth	Mean	Gear	Nav.	Position		HC	HM	PS
55009#2	Site T	17/08	08:57	527	527	BOX CORE	SHIP	60 06.18N	007 14.49W	Y	Y	Y
55010#1	Site W	17/08	11:51	510	510	WASP	GEAR	60 02.49N	007 28.60W	-	-	-
		17/08	12:58	509				60 03.36N	007 27.71W			
55010#2	Site W	17/08	14:13	507	507	BOX CORE	GEAR	60 02.43N	007 28.46W	Y	Y	Y
55011#1	Site E	17/08	17:27	476	476	WASP	GEAR	60 00.93N	007 12.92W	-	-	-
		17/08	18:34	475				60 00.89N	007 12.34W			
55012#1	FBC500	17/08	19:57	497	497	BOX CORE	GEAR	60 04.29N	007 08.45W	-	-	-
55012#2	FBC500	17/08	20:54	480	480	BOX CORE	GEAR	60 03.90N	007 08.34W	-	-	-
55012#3	FBC500	17/08	21:40	477	477	BOX CORE	GEAR	60 03.77N	007 08.31W	-	-	-
55012#4	FBC500	17/08	22:54	522	513	WASP	GEAR	60 04.32N	007 06.39W	-	-	-
		18/08	00:00	505				60 04.42N	007 04.43W			
55013#1	Site N1	18/08	04:28	1058	1058	MEGA06	GEAR	60 14.03N	006 10.07W	-	-	-
55013#2	Site N1	18/08	06:07	1134	1134	MEGA04	GEAR	60 13.61N	006 10.07W	-	-	-
55014#1	Site N2	18/08	08:01	1195	1195	MEGA04	SHIP	60 11.77N	006 10.05W	Y	Y	-
55014#2	Site N2	18/08	09:51	1227	1231	WASP	GEAR	60 11.67N	006 11.28W	-	-	-
		18/08	10:18	1235				60 11.71N	006 11.69W			
55015#1	Site N1	18/08	12:04	1167	1163	WASP	GEAR	60 13.35N	006 10.39W	-	-	-
		18/08	12:35	1159				60 13.60N	006 10.51W			
55015#2	Site N1	18/08	14:18	1132	1132	BOX CORE	GEAR	60 13.66N	006 10.38W	-	-	Y
55016#1	Site P	18/08	17:49	1196	1195	WASP	GEAR	60 12.05N	006 04.71W	-	-	-
		18/08	18:56	1194				60 12.07N	006 05.40W			
55017#1	FSC300	19/08	00:01	261	263	WASP	GEAR	59 53.19N	005 09.74W	-	-	-
		19/08	01:05	265				59 53.30N	005 09.03W			

Station	Site	Date	Time	Depth	Mean	Gear	Nav.	Position			HC	HM	PS
55018#1	FSC500	19/08	03:27	500	500	BOX CORE	SHIP	59 56.53N	005	18.28W	-	-	Y
55018#2	FSC500	19/08	17:39	498	488	WASP	GEAR	59 56.41N	005	18.75W	-	-	-
		19/08	18:13	479				59 56.62N	005	19.07W			
55019#1	FSC800	19/08	20:20	766	765	WASP	GEAR	59 59.78N	005	30.59W	-	-	-
		19/08	20:54	764				59 59.70N	005	31.27W			
55020#1	FSC1000	19/08	23:41	963	970	WASP	GEAR	60 03.90N	005	42.56W	-	-	-
		20/08	00:11	977				60 03.84N	005	43.17W			
55021#1	FSC1200	20/08	03:42	1175	1134	WASP	SHIP	60 09.49N	005	57.70W	-	-	-
		20/08	04:18	1093				60 09.43N	005	57.53W			
55022#1	Site L	20/08	10:03	1045	1030	WASP	SHIP	60 03.85N	006	17.80W	-	-	-
		20/08	11:10	1014				60 04.06N	006	18.67W			
55022#2	Site L	20/08	12:44	1062	1062	MEGA04	SHIP	60 03.97N	006	46.48W	Y	Y	Y
55023#1	Site J	20/08	14:58	990	990	WASP	GEAR	60 01.54N	006	19.64W	-	-	-
		20/08	15:30	990				60 01.52N	006	19.20W			
55023#2	Site J	20/08	16:39	1001	1001	MEGA04	GEAR	60 01.50N	006	19.93W	Y	Y	Y
55024#1	Site K	20/08	18:18	563	518	WASP	GEAR	59 59.92N	006	22.31W	-	-	-
		20/08	18:48	473				59 59.85N	006	22.48W			
55024#2	Site K	20/08	19:44	719	719	BOX CORE	GEAR	60 00.09N	006	22.18W	-	-	-
55025#1	Site G1	20/08	21:59	529	566	WASP	GEAR	59 55.25N	006	15.68W	-	-	-
		20/08	22:31	602				59 55.01N	006	15.68W			
55026#1	Site G2	20/08	23:40	491	478	WASP	GEAR	59 54.57N	006	19.73W	-	-	-
		21/08	00:11	465				59 54.55N	006	20.00W			

Station	Site	Date	Time	Depth	Mean	Gear	Nav.	Position		HC	HM	PS
55027#1	Site V	21/08	01:58	361	360	WASP	GEAR	59 56.01N	006 30.20W	-	-	-
		21/08	02:28	358				59 56.07N	006 30.13W			
55028#1	FSC1200	21/08	06:03	1168	1133	WASP	GEAR	60 09.29N	005 57.26W	-	-	-
		21/08	06:40	1098				60 09.11N	005 56.35W			
55028#2	FSC1200	21/08	08:27	1159	1159	BOX CORE	SHIP	60 09.17N	005 58.17W	-	-	-
55029#1	FSC1000	21/08	11:28	969	969	MEGA06	GEAR	60 03.92N	005 42.33W	Y	Y	Y
55030#1	Site R1	21/08	15:32	1131	1126	WASP	GEAR	60 09.77N	005 48.69W	-	-	-
		21/08	16:04	1120				60 09.55N	005 47.98W			
55031#1	Site R2	21/08	19:03	1142	1136	WASP	GEAR	60 11.09N	005 44.06W	-	-	-
		21/08	19:35	1131				60 10.73N	005 43.49W			
55032#1	Site Q	21/08	22:16	1089	1069	WASP	GEAR	60 13.22N	005 50.36W	-	-	-
		21/08	22:47	1049				60 12.66N	005 49.96W			
55033#1	Site S	22/08	02:52	954	953	WASP	GEAR	60 13.38N	005 16.97W	-	-	-
		22/08	03:24	952				60 13.34N	005 16.72W			
55034#1	TOBI	22/08				TOBI				-	-	-
55035#1	Site X1	22/08	15:46	880	900	WASP	SHIP	60 42.39N	004 03.22W	-	-	-
		22/08	16:50	919				60 41.95N	004 01.80W			
55036#1	TOBI	22/08	08:05			TOBI				-	-	-
55036#2	TOBI	22/08	10:32			TOBI				-	-	-
55036#3	TOBI	22/08	20:10			TOBI				-	-	-
55037#1	Site X1	22/08	22:01	905	905	MEGA06	GEAR	60 42.28N	004 02.79W	-	-	-
55037#2	Site X1	22/08	23:21	910	910	MEGA04	GEAR	60 42.35N	004 02.91W	Y	Y	Y

Station	Site	Date	Time	Depth	Mean	Gear	Nav.	Position			HC	HM	PS
55038#1	Site X2	23/08	02:42	1094	1091	WASP	GEAR	60 49.81N	004 10.47W		-	-	-
		23/08	03:14	1088				60 49.64N	004 10.80W				
55039#1	Site X3	23/08	06:49	1128	1126	WASP	GEAR	60 59.92N	004 00.80W		-	-	-
		23/08	07:27	1124				60 59.81N	004 01.70W				
55040#1	TOBI	23/08	10:43			TOBI					-	-	-
55041#1	Site X2	23/08	19:06	1028	1028	MEGA06	SHIP	60 49.95N	004 09.26W		Y	Y	Y
55042#1	Site X3	23/08	22:38	1117	1117	MEGA06	SHIP	60 59.81N	004 01.10W		Y	Y	Y
55043#1	Site Y1	24/08	03:00	1022	1020	WASP	SHIP	60 37.12N	004 15.96W		-	-	-
		24/08	04:00	1019				60 37.49N	004 15.93W				
55044#1	TOBI	24/08	08:30			TOBI					-	-	-
55045#1	FPS1800	30/08	21:38	1726	1725	WASP	SHIP	62 29.24N	001 55.09W		-	-	-
		30/08	22:43	1724				62 29.11N	001 55.04W				
55046#1	FPS1500	31/08	01:55	1443	1444	WASP	SHIP	62 31.63N	002 07.73W		-	-	-
		31/08	02:25	1445				62 31.66N	002 07.77W				
55047#1	FPS1000	31/08	04:44	981	984	WASP	SHIP	62 33.20N	002 14.43W		-	-	-
		31/08	05:15	987				62 33.07N	002 14.51W				
55048#1	TOBI	31/08	08:45			TOBI					-	-	-
55049#1	NS1	05/09	17:20	2279	2275	WASP	SHIP	63 36.14N	000 48.00W		-	-	-
		05/09	17:51	2271				63 36.10N	000 47.11W				
55049#2	NS1	05/09	20:48	2280	2280	MEGA08	SHIP	63 36.23N	000 48.98W		Y	Y	Y
55050#1	NS2	06/09	00:25	2117	2130	WASP	SHIP	63 32.82N	000 54.75W		-	-	-
		06/09	01:00	2143				63 32.51N	000 54.49W				
55050#2	NS2	06/09	04:00	2159	2159	MEGA08	SHIP	63 33.24N	000 52.75W		-	-	-

Station	Site	Date	Time	Depth	Mean	Gear	Nav.	Position		HC	HM	PS
55050#3	NS2	06/09	06:37	2276	2276	MEGA06	SHIP	63 33.53N	000 53.55W	Y	Y	Y
55051#1	NS3	06/09	13:50	1471	1472	WASP	SHIP	62 48.42N	000 41.05W	-	-	-
		06/09	14:56	1472				62 48.52N	000 40.49W			
55051#2	NS3	06/09	16:41	1470	1470	MEGA08	SHIP	62 48.61N	000 40.64W	Y	Y	Y
55052#1	NS4	06/09	20:32	1613	1601	WASP	SHIP	62 39.15N	001 20.22W	-	-	-
		06/09	21:40	1589				62 39.58N	001 21.46W			
55052#2	NS4	07/09	00:00	1593	1593	BOX CORE	SHIP	62 39.33N	001 20.32W	Y	Y	Y
55053#1	FPN1	07/09	05:05	1741	1731	WASP	SHIP	62 44.53N	001 43.80W	-	-	-
		07/09	06:50	1721				62 44.29N	001 45.30W			
55054#1	FPN1800	07/09	09:00	1701	1701	MEGA08	SHIP	62 44.83N	001 51.90W	Y	Y	Y
55055#1	FPN1	07/09	11:48	1738	1744	WASP	SHIP	62 44.95N	001 41.60W	-	-	-
		07/09	12:57	1750				62 44.52N	001 42.10W			
55056#1	FPN1400	07/09	15:39	1354	1354	MEGA08	SHIP	62 40.35N	002 01.51W	Y	Y	Y
55056#2	FPN1400	07/09	17:31	1352	1356	WASP	SHIP	62 40.25N	002 01.04W	-	-	-
		07/09	18:03	1359				62 40.16N	002 01.78W			
55057#1	FPN1100	07/09	19:48	1078	1079	WASP	SHIP	62 38.11N	002 08.83W	-	-	-
		07/09	20:23	1080				62 38.24N	002 09.63W			
55057#2	FPN1100	07/09	22:03	1080	1080	MEGA08	SHIP	62 38.29N	002 08.72W	Y	-	Y
55058#1	FPN2	08/09	00:18	1062	1063	WASP	SHIP	62 34.97N	002 08.23W	-	-	-
		08/09	01:25	1064				62 34.83N	002 08.59W			

11.2 Comments and other samples

The following listing provides a simple comment on each deployment made during the cruise and lists samples collected other than primary survey samples. For station data and information on primary survey samples see the preceding listing in section 11.1.

Station & Site See section 11.1 for definitions.

Comment & Other samples Refer to glossary below.

Glossary

archive frozen core	core frozen hole as archive material
ATS	ultra-short baseline navigation system
'black hole'	area of very low sidescan sonar returns, associated with contourite sand deposit
data discs	magneto-optical storage media for TOBI data
epifauna	surface dwelling fauna
forams	foraminiferans (shelled protozoans)
galatheids	squat lobsters
iceberg ploughmarks	seabed impressions or other indications of iceberg groundings
live core	sediment core with supernatant water maintained at habitat temperature and returned to SOC for live study
Mk7	WASP still camera
ophiuroids	brittle stars
PSA	particle size analysis sample
pycnogonids	sea spiders
sabellids	tube-dwelling polychaete worms
TBT	sample for tri-butyl tin analysis
trawl marks	seabed impressions likely caused by demersal trawling
umbilical	part of TOBI vehicle towing system
xenophyophores	a type of 'giant' single-celled organism.
x m film	x metres of colour film exposed
x mins DV	x minutes of digital video footage
x/x	x good quality cores recovered from /x core units deployed on the megacorer.

Station	Site	Comment	Other samples
55001#1	DMounds	Long-term deployment	
55002#1	Site A	Good run, corals and xenophyophores	60 mins DV, 12 m film
55002#2	Site A	Aborted midwater	
55002#3	Site A	2/6 short bubbled cores, discarded	
55002#4	Site A	0/6, water only, one no fire	
55003#1	Site B	Good video, rocky ground	60 mins DV, 30 m film with 55005#2
55004#1	Site C	6/6 Cores	
55005#1	FBC1200	4/6, 2 good, 2 cloudy	Live core for S Suhr (SOC)
55005#2	FBC1200	Good run, stalked sponge ground	60 mins DV, 30 m film with 55003#1
55006#1	FBC1000	Good tow, lots of little tubes laid on seafloor	60 mins DV, 30 m film with 55007#1
55006#2	FBC1000	0/6, some small gravel (5 mm) recovered	
55006#3	FBC1000	2/4 cores	
55007#1	FBC800	Good tow, boulders with tubular sponges	60 mins DV, 30 m film with 55006#1
55007#2	FBC800	0/4	Sponge, forams
55007#3	FBC800	0/4, two short washed out	Sponge, forams
55008#1	FBC500	0/4, cracked a tube	Sponge, galatheids
55008#2	FBC500	0/4 cores	
55009#1	Site T	0/4 cores	
55009#2	Site T	Good core, gravel / cobble pavement	Selection of invertebrates
55010#1	Site W	Good tow, rocky to gravelly ground	60 mins DV, 30 m film with 55011#1
55010#2	Site W	Good core	Selection of invertebrates
55011#1	Site E	Good tow, varied ground: gravel to rocks	60 mins DV, 30 m film with 55010#1
55012#1	FBC500	Rocks and washed out sediment only, box bent	

Station	Site	Comment	Other samples
55012#2	FBC500	Washed out coarse sand over mud	
55012#3	FBC500	Washed out sandy sediment, box bent	
55012#4	FBC500	Good tow, varied dense gravel to rock and cobble	60 mins DV, 32 m film with 55014#2 and 15#1
55013#1	Site N1	0/6 water only	
55013#2	Site N1	0/4 water only	
55014#1	Site N2	2/4 cores, gravelly sand over mud	Ophiuroids (frozen)
55014#2	Site N2	Good tow, featureless fine gravel over sand	30 mins DV, 32 m film with 55012#4 and 15#1
55015#1	Site N1	Good tow, cobble gravel pavement, variable rocks	30 mins DV, 32 m film with 55012#4 and 14#2
55015#2	Site N1	Part washed out, PSA sample only	Selected invertebrates
55016#1	Site P	Good tow, similar ground to Site N1	60 mins DV, 30 m film with 55017#1
55017#1	FSC300	Good tow, iceberg ploughmarks, trawl marks	60 mins DV, 30 m film with 55016#1
55018#1	FSC500	Sample part washed out	
55018#2	FSC500	Good tow, iceberg ploughmarks, limited epifauna	30 mins DV, 30 m film with 19#1,20#1 and 21#1
55019#1	FSC800	Good tow, muddier sand ground	30 mins DV, 30 m film with 18#1,20#1 and 21#1
55020#1	FSC1000	Good tow, stalked sponge ground	30 mins DV, 30 m film with 18#1,19#1 and 21#1
55021#1	FSC1200	Short video, seafloor strongly rippled	14 mins DV, 30 m film with 18#1,19#1 and 20#1
55022#1	Site L	Good tow, stalked sponge ground	60 mins DV, 30 m film with 23#1 and 24#1
55022#2	Site L	4/4 cores, sand over mud	Live core for S Suhr (SOC), pycnogonids
55023#1	Site J	Good tow, variant of stalked sponge ground	30 mins DV, 30 m film with 22#1 and 24#1
55023#2	Site J	3/4 cores	
55024#1	Site K	Good tow, very rocky, feather star carpet	30 mins DV, 30 m film with 22#1 and 23#1
55024#2	Site K	Completely empty	
55025#1	Site G1	Good tow, gravel to very rocky, feather stars	30 mins DV, 30 m film with 22#1 and 23#1

Station	Site	Comment	Other samples
55026#1	Site G2	Good tow, cobble / gravel pavement, feather stars	30 mins DV, 30 m film with 25#1,27#1 and 28#1
55027#1	Site V	Good tow, gravelly sand, ? trawl mark	30 mins DV, 30 m film with 25#1,26#1 and 28#1
55028#1	FSC1200	Good tow, strongly rippled sandy sediment	30 mins DV, 30 m film with 25#1,26#1 and 27#1
55028#2	FSC1200	Washed out, no samples	
55029#1	FSC1000	5/6 cores	Whole frozen core, live core
55030#1	Site R1	Good two, sand with gravel streaks	30 mins DV, 30 m film with 31#1,32#1 and 33#1
55031#1	Site R2	Good tow, sand with gravel streaks	30 mins DV, 30 m film with 30#1,32#1 and 33#1
55032#1	Site Q	Good tow, cobbly bottom with gravel ribbons	30 mins DV, 30 m film with 33#1,31#1 and 33#1
55033#1	Site S	Good tow, 'Black Hole' contourite	30 mins DV, 30 m film with 30#1,31#1 and 32#1
55034#1	TOBI	Aborted, excess noise on sidescan	
55035#1	Site X1	Good tow, sandy ground with rocks and gravel	60 mins DV, 15 m film
55036#1	TOBI	ATS beacon not switched on, umbilical damage	No data
55036#2	TOBI	Noise on sidescan, no ATS function	No data
55036#3	TOBI	Short circuit on umbilical	No data
55037#1	Site X1	1/6, very short, discarded	
55037#2	Site X1	4/4 cores	
55038#1	Site X2	Good tow, sandy ground with rocks and gravel	30 mins DV, 30 m film with 39#1 and 43#1
55039#1	Site X3	Good tow, sandy ground with rocks and gravel	30 mins DV, 30 m film with 38#1 and 43#1
55040#1	TOBI	Noise on sidescan	No data
55041#1	Site X2	5/6 cores	Archive frozen, live core
55042#1	Site X3	6/6 cores, one slumped	Archive frozen core
55043#1	Site Y1	Good tow, sandy ground with rocks	62 mins DV, 30 m film with 38#1 and 39#1
55044#1	TOBI	Complete legs 1-16 and part 17	Data discs 1-6 and 20

Station	Site	Comment	Other samples
55045#1	FPS1800	MK7 drive belt snapped, no film run	60 mins DV, (no film)
55046#1	FPS1500	Good tow, sandy with plenty gravel and cobbles	30 mins DV, 15 m film with 55047#1
55047#1	FPS1000	Good tow, sandy with plenty gravel and cobbles	30 mins DV, 15 m film with 55046#1
55048#1	TOBI	Complete legs 19-25 in revised forms.	Data discs 6a-11
55049#1	NS1	Mk7 stopped early.	30 mins DV, (no film)
55049#2	NS1	4/8 cores	Live core (S Suhr)
55050#1	NS2	Mk7 failed on descent.	30 mins DV, (no film)
55050#2	NS2	1/8 short, leaking core, discarded	
55050#3	NS2	3/6 cores	
55051#1	NS3	Good tow, dense brittlestars	60 mins DV, 30m film with 55052#1
55051#2	NS3	5/8 cores (1 lost on deck)	Live core (S Suhr)
55052#1	NS4	Good tow, crosses minor scarps	60 mins DV, 30m film with 55051#1
55052#2	NS4	Soft mud over soft clay	Frozen subcore, TBT (M Hartl)
55053#1	FPN1	Autofocus on at recovery.	20 mins DV, 30 m film with 55055#1
55054#1	FPN1800	Soft sediment	TBT (M Hartl)
55055#1	FPN1	Good tow, mostly muddy ground, one ‘lump’	60 mins DV, 30 m film with 55053#1
55056#1	FPN1400	Number of ophiuroids present	Live core (S Suhr), ophiuroids
55056#2	FPN1400	Good tow, sabellids and ophiuroids	30 mins DV, 30 m film with 57#1 and 58#1
55057#1	FPN1100	Good tow, more rocks and gravel than deeper	30 mins DV, 30 m film with 56#1 and 58#1
55057#2	FPN1100	2/8 very short cores	
55058#1	FPN2	Good tow, gravelly and cobbly ground	60 mins DV, 30 m film with 56#1 and 57#1

12. CHARTS

Chart 1.	Cruise track
Chart 2.	TOBI track
Chart 3.	WASP and coring sites, part 1
Chart 4.	WASP and coring sites, part 2
Chart 5.	WASP and coring sites, part 3
Charts 6-48.	Individual WASP tracks (where two tracks are shown these represent the survey vessel and the WASP vehicle as located by the USBL system)

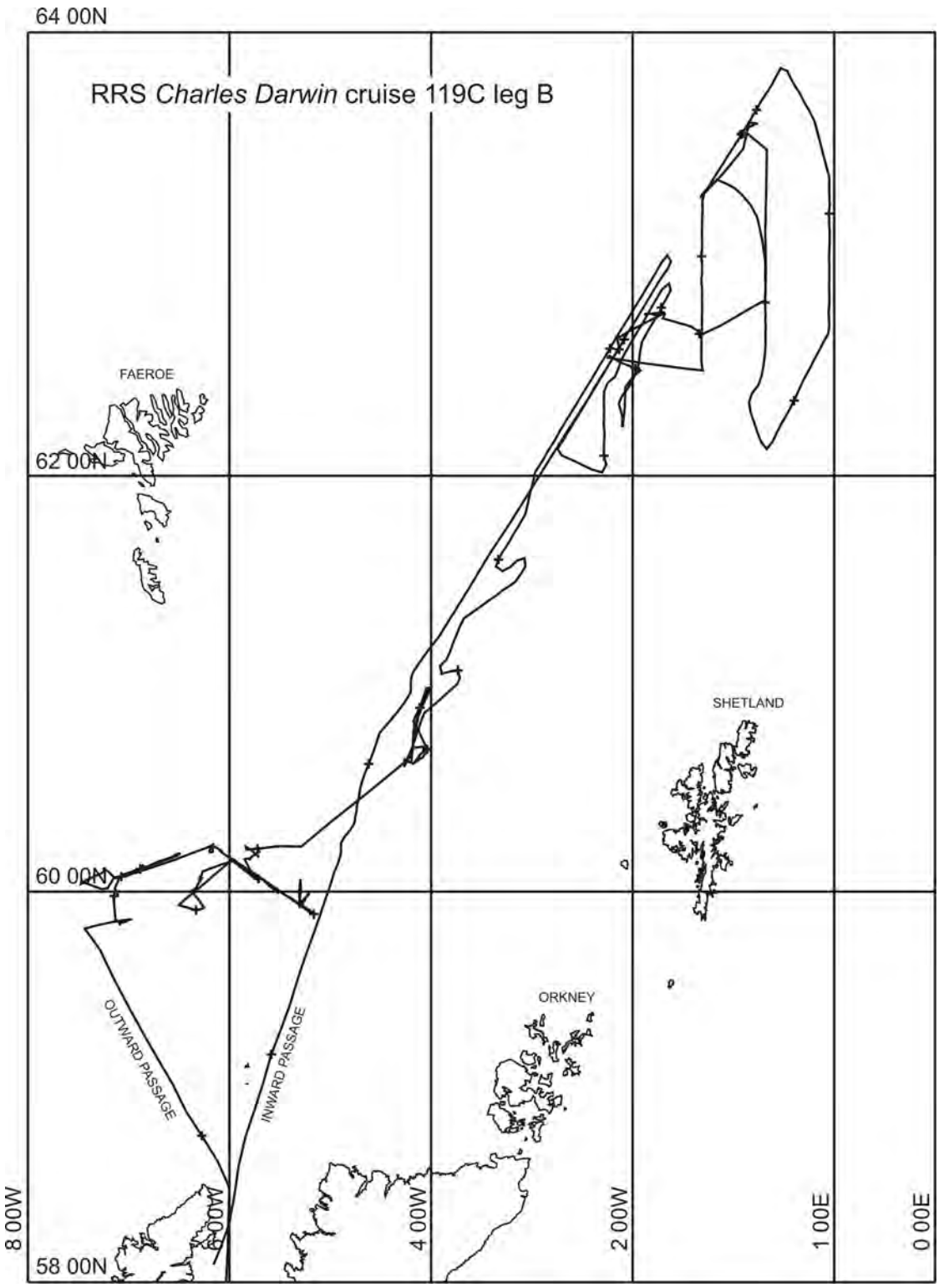

Chart 1. Cruise track for RRS *Charles Darwin* cruise 119C leg B, 13 Aug-14 Sept 1999, Govan to Southampton.

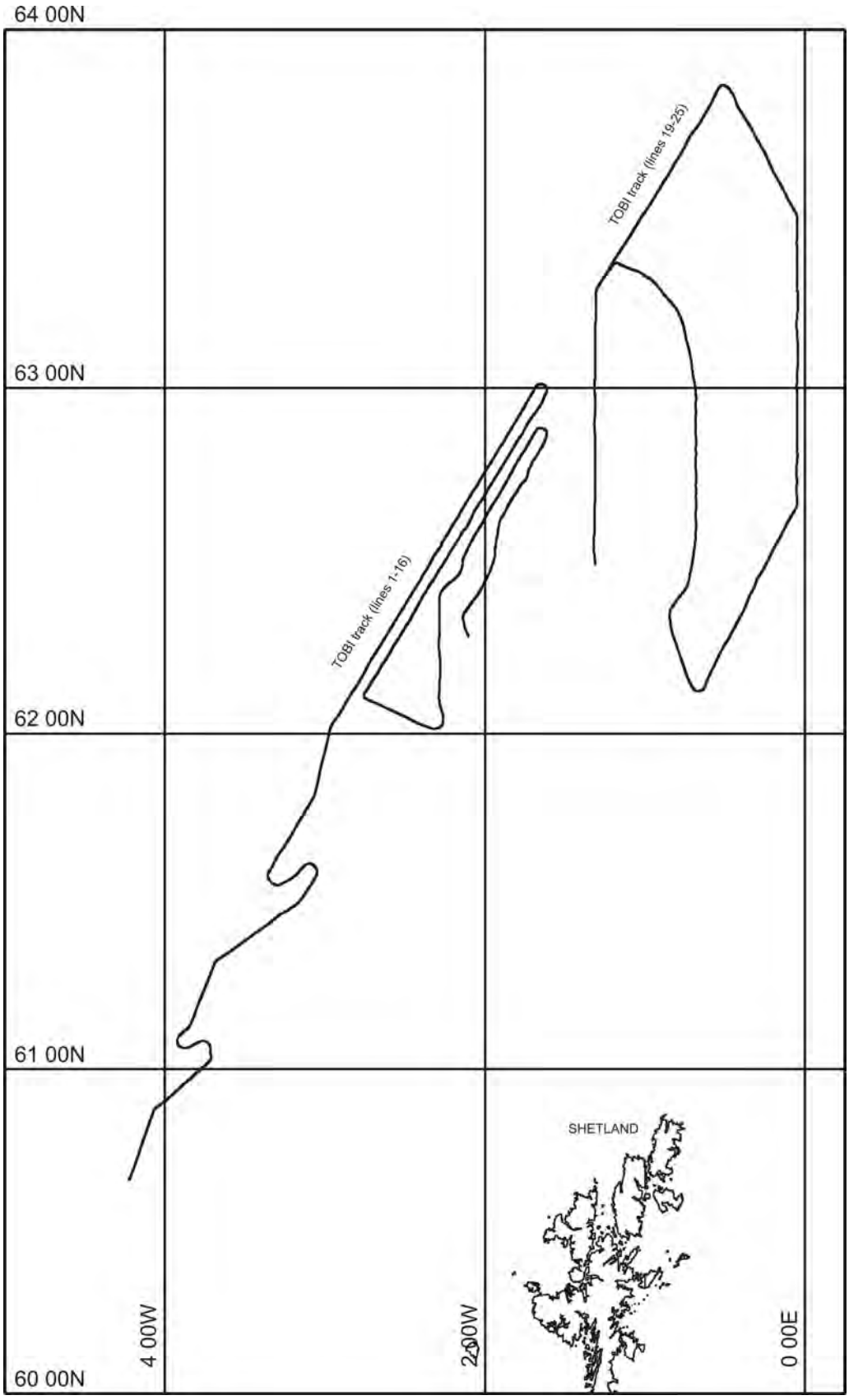

Chart 2. TOBI sidescan sonar vehicle track during RRS *Charles Darwin* cruise 119C leg B.

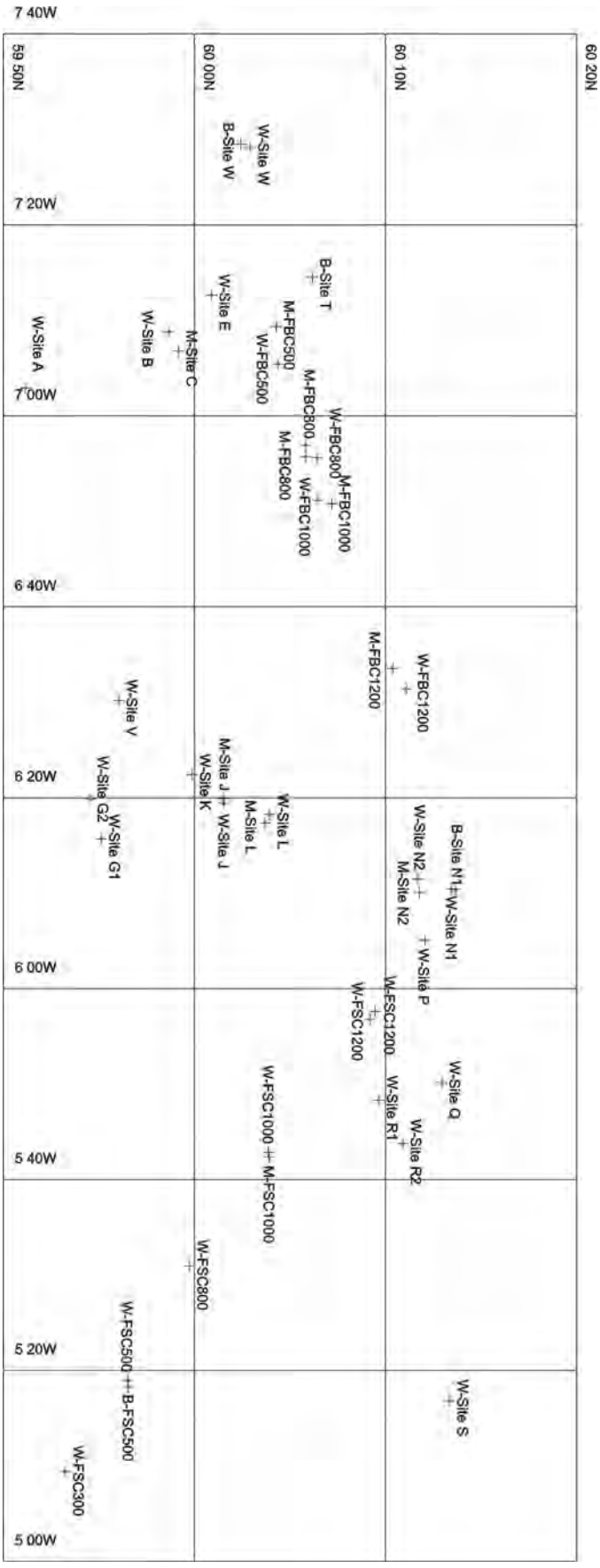

Chart 3. WASP (W) and coring (B / M) sites successfully occupied during RRS *Charles Darwin* cruise 119C leg B, part 1.

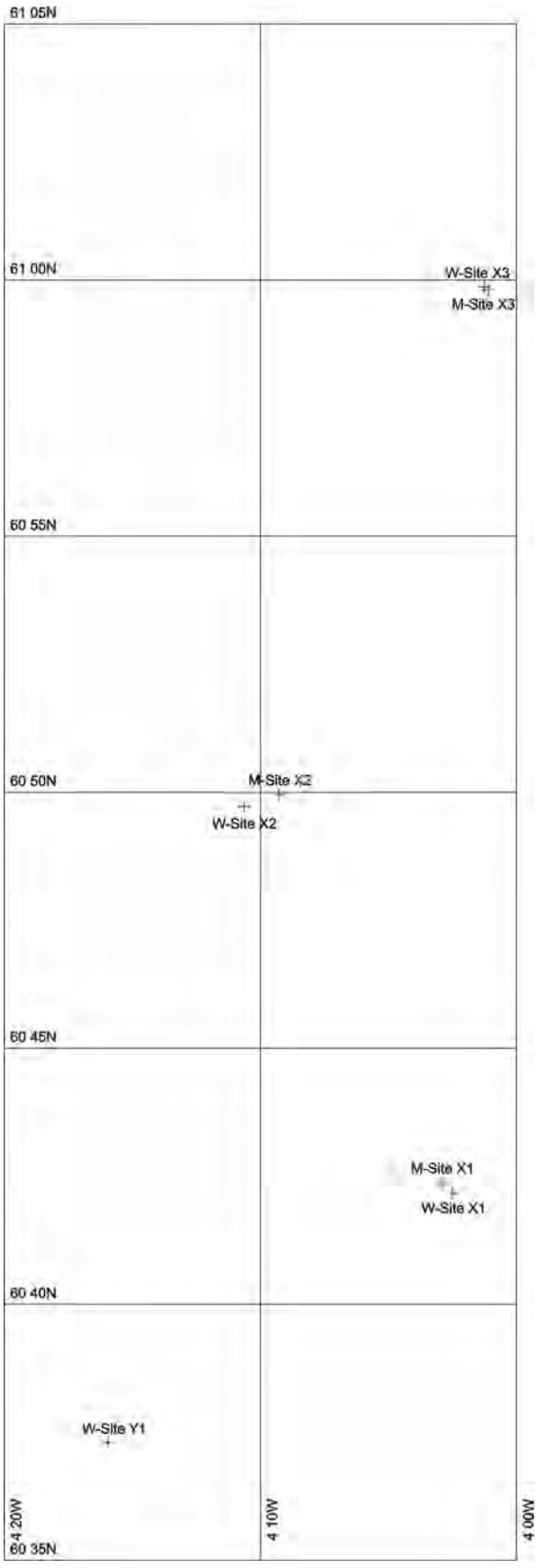

Chart 4. WASP (W) and coring (B / M) sites successfully occupied during RRS *Charles Darwin* cruise 119C leg B, part 2.

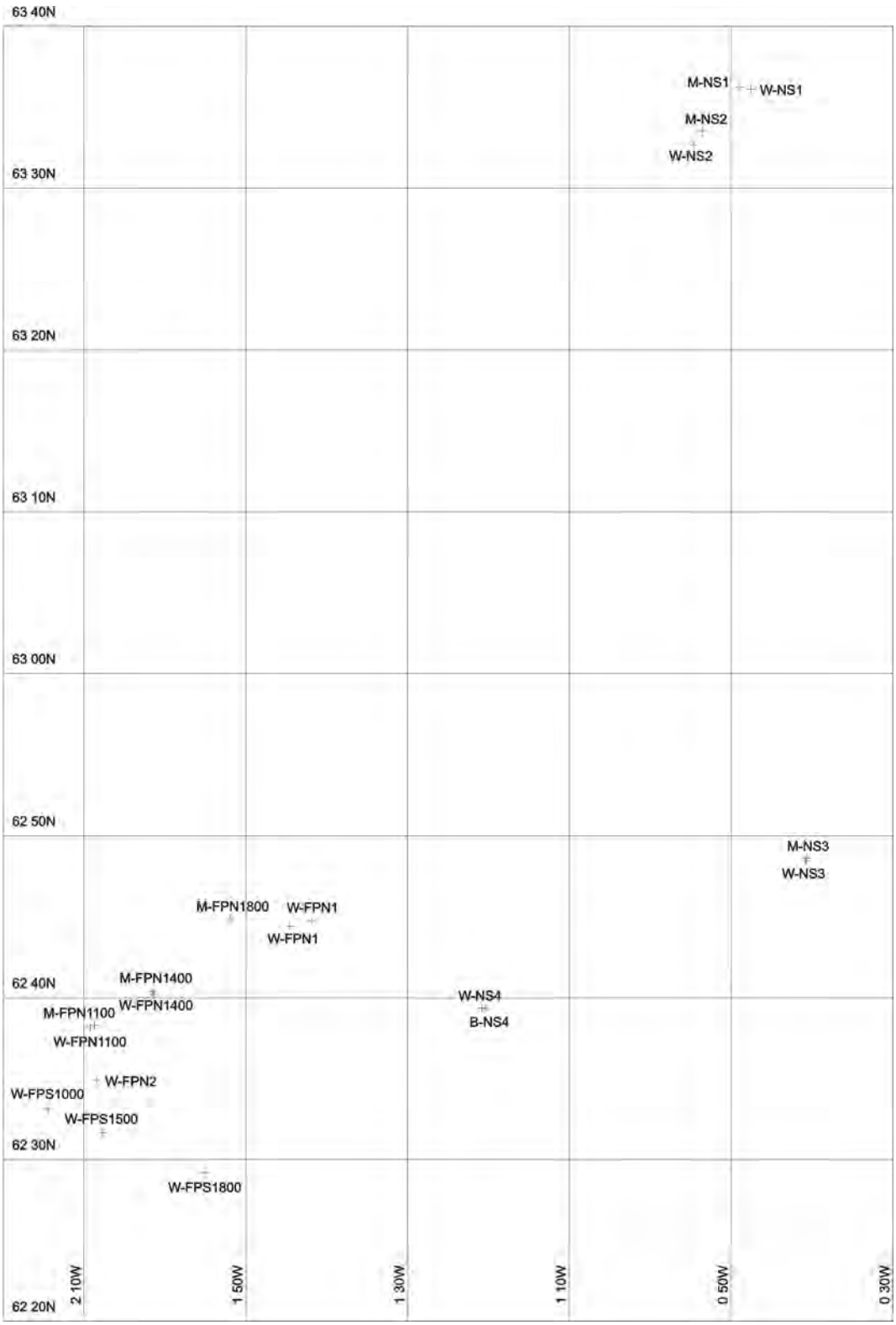

Chart 5. WASP (W) and coring (B / M) sites successfully occupied during RRS *Charles Darwin* cruise 119C leg B, part 3.

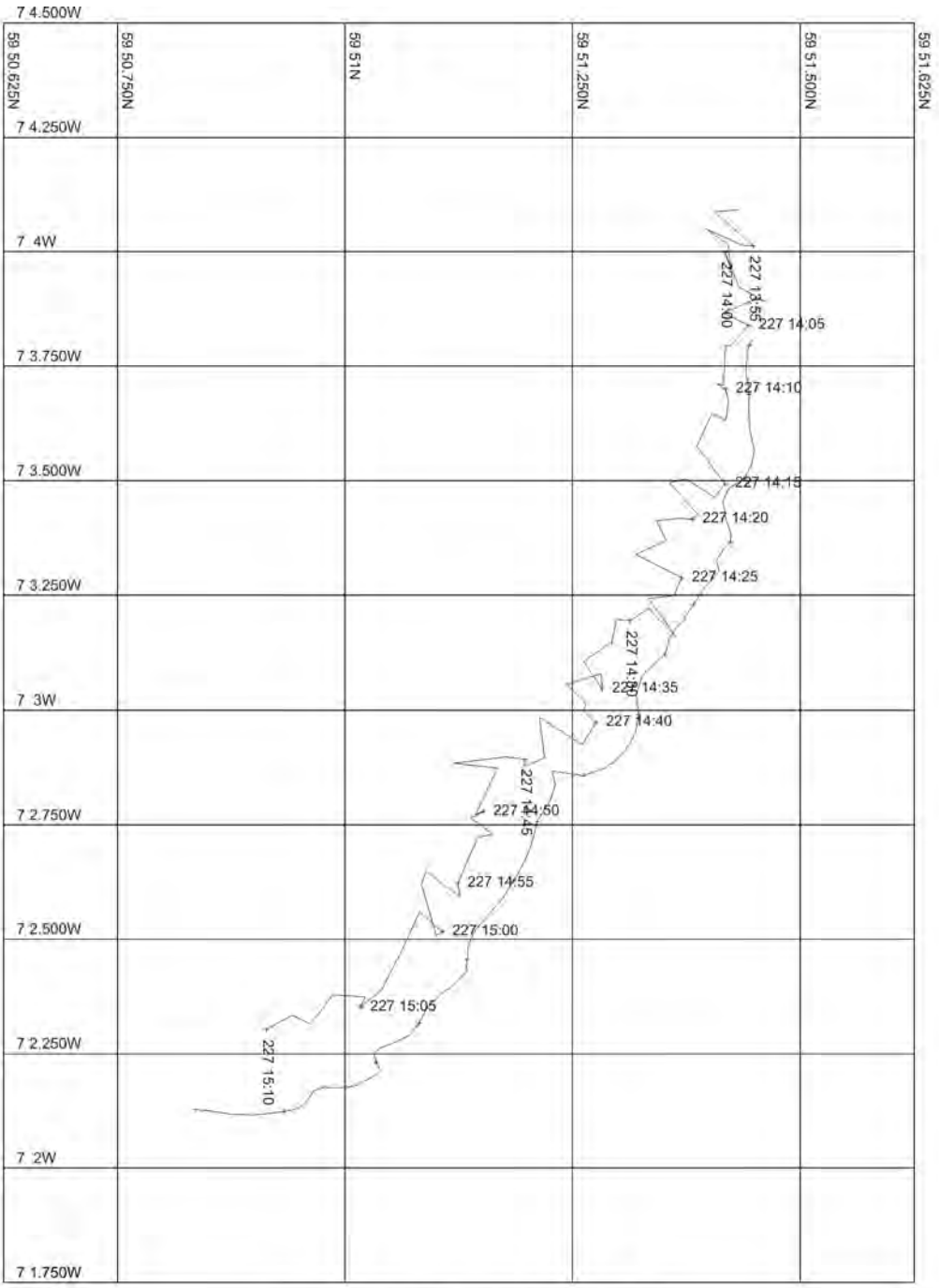

Chart 6. WASP 55002#1, Site A

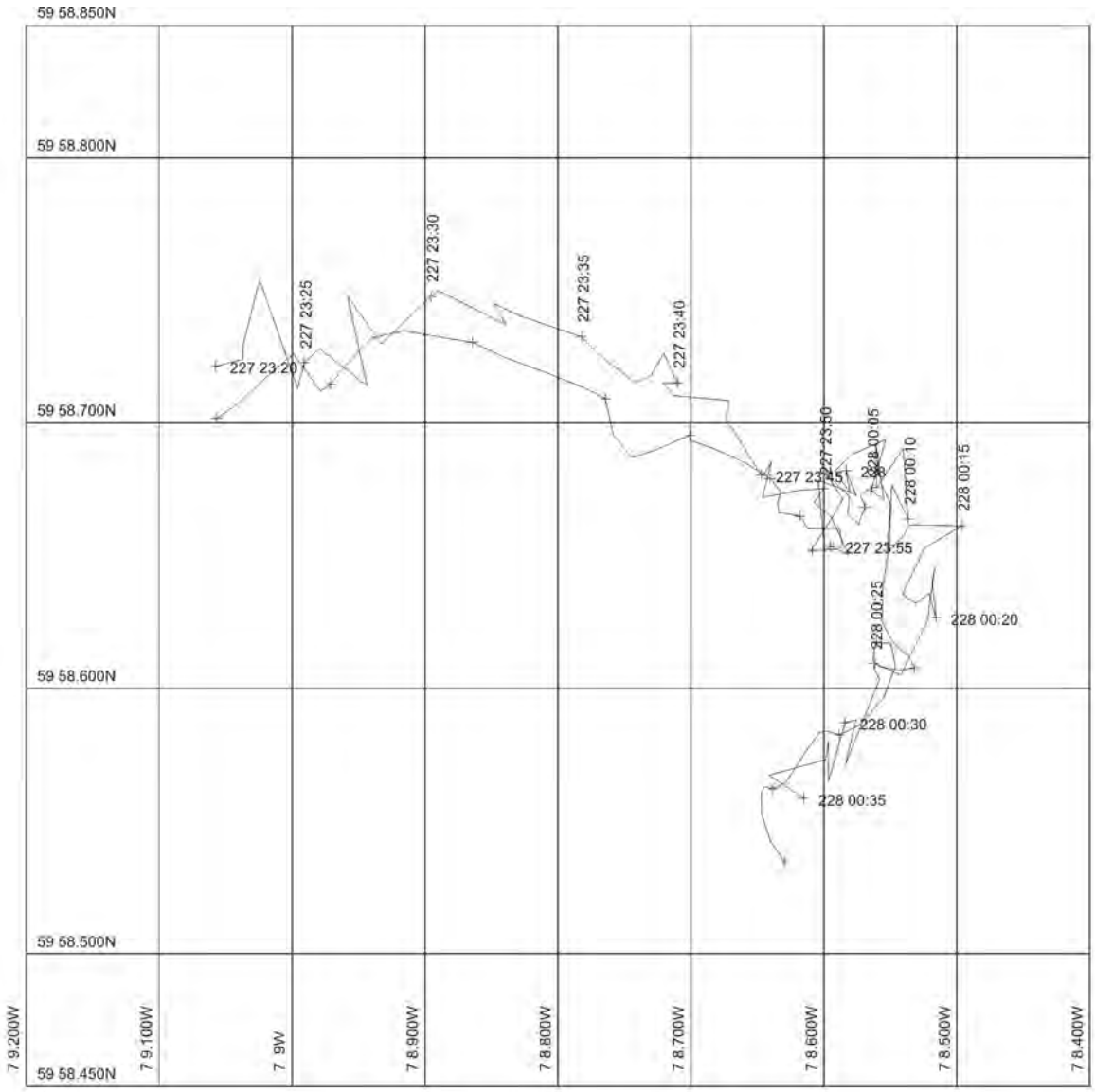

Chart 7. WASP 55003#1, Site B

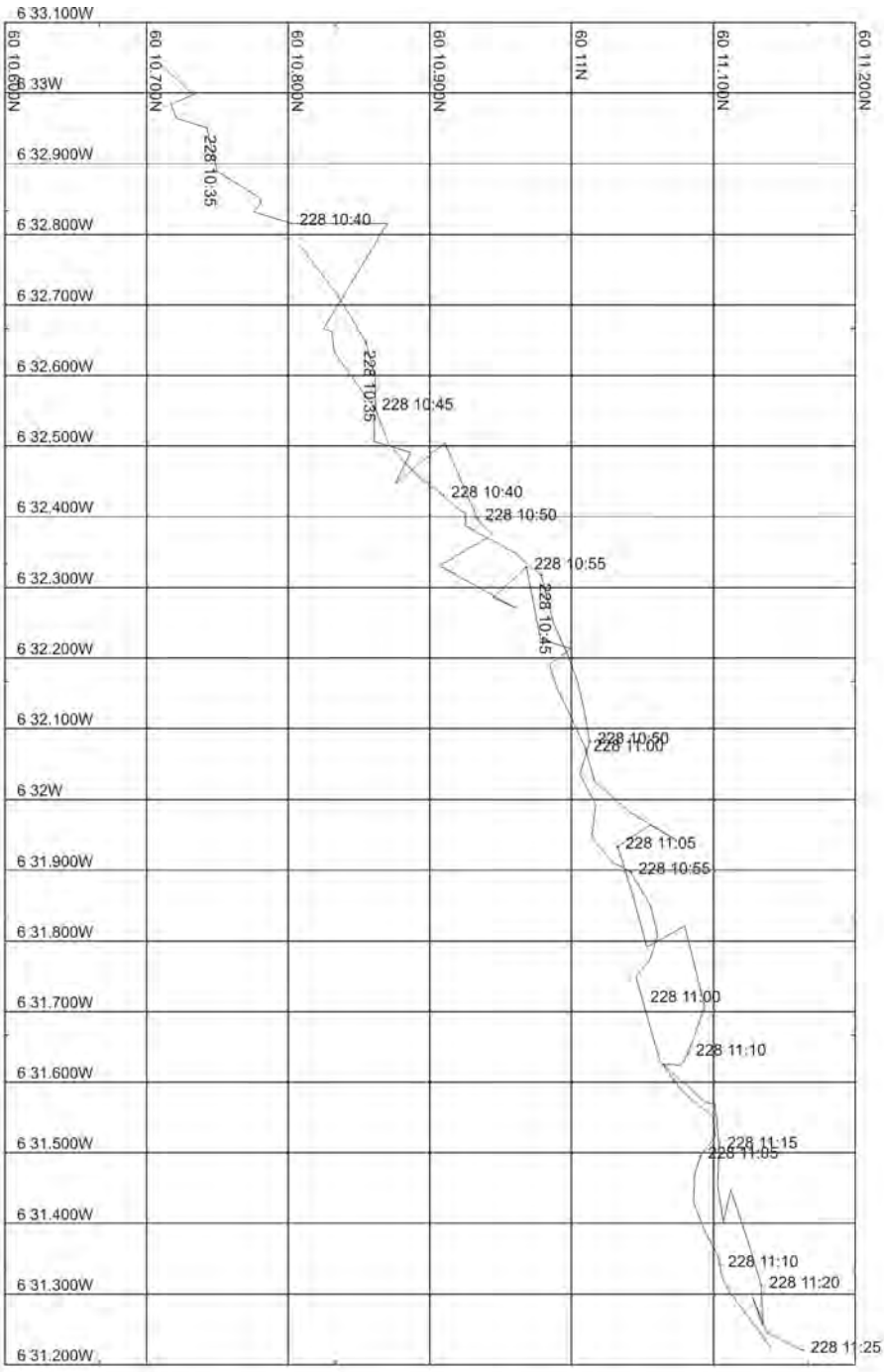

Chart 8. WASP 55005#2, Site FBC1200

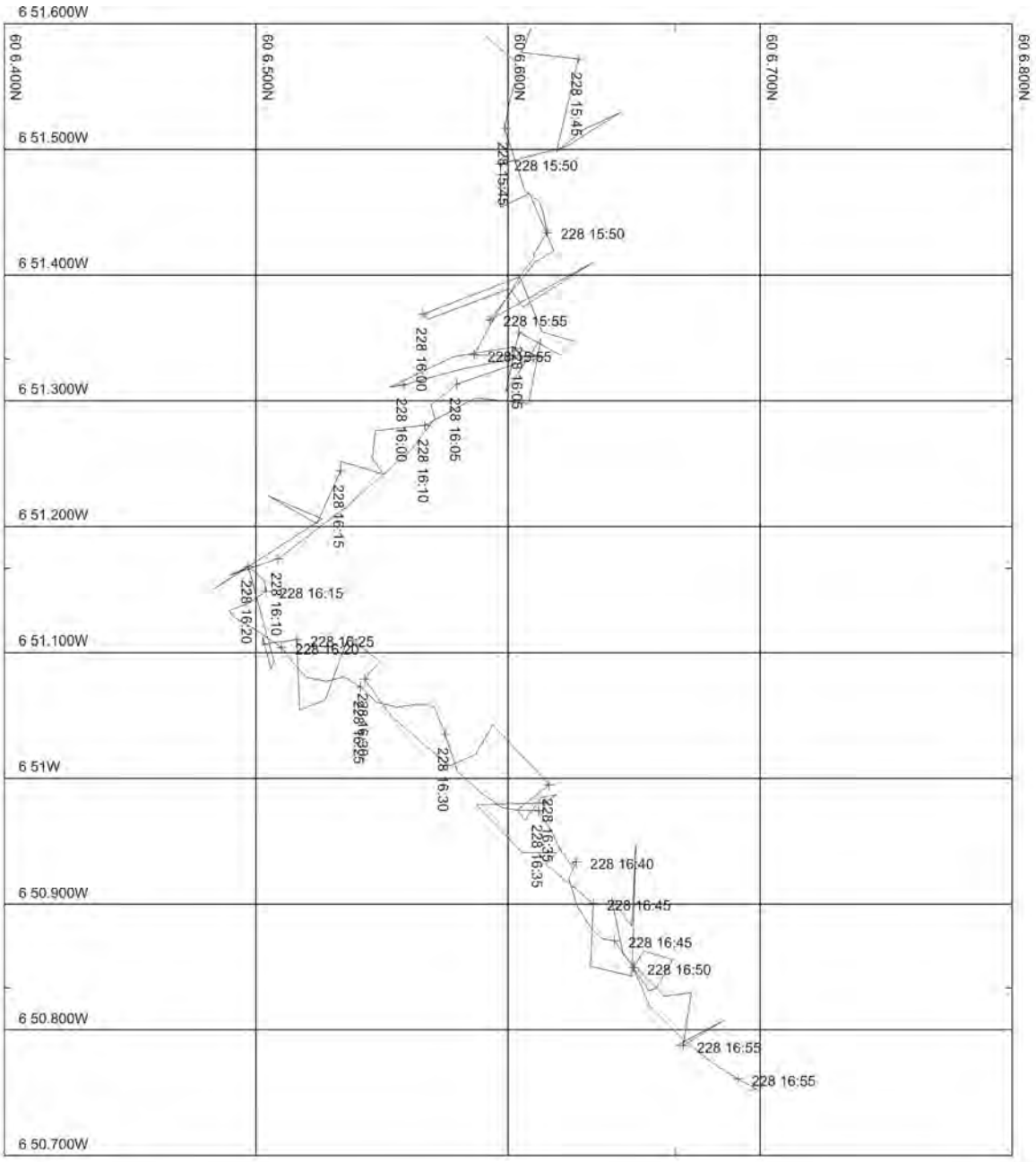

Chart 9. WASP 55006#1, Site FBC1000

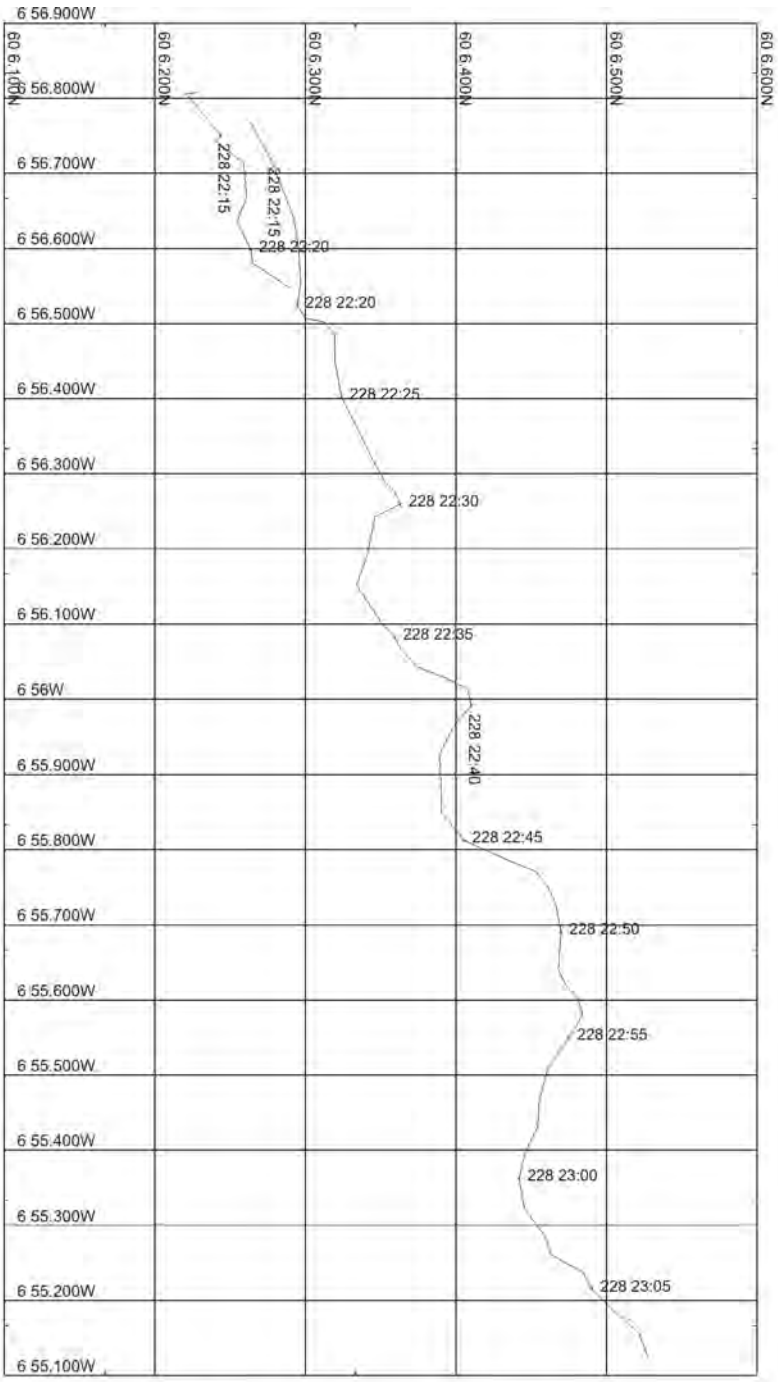

Chart 10. WASP 55007#1, Site FBC800

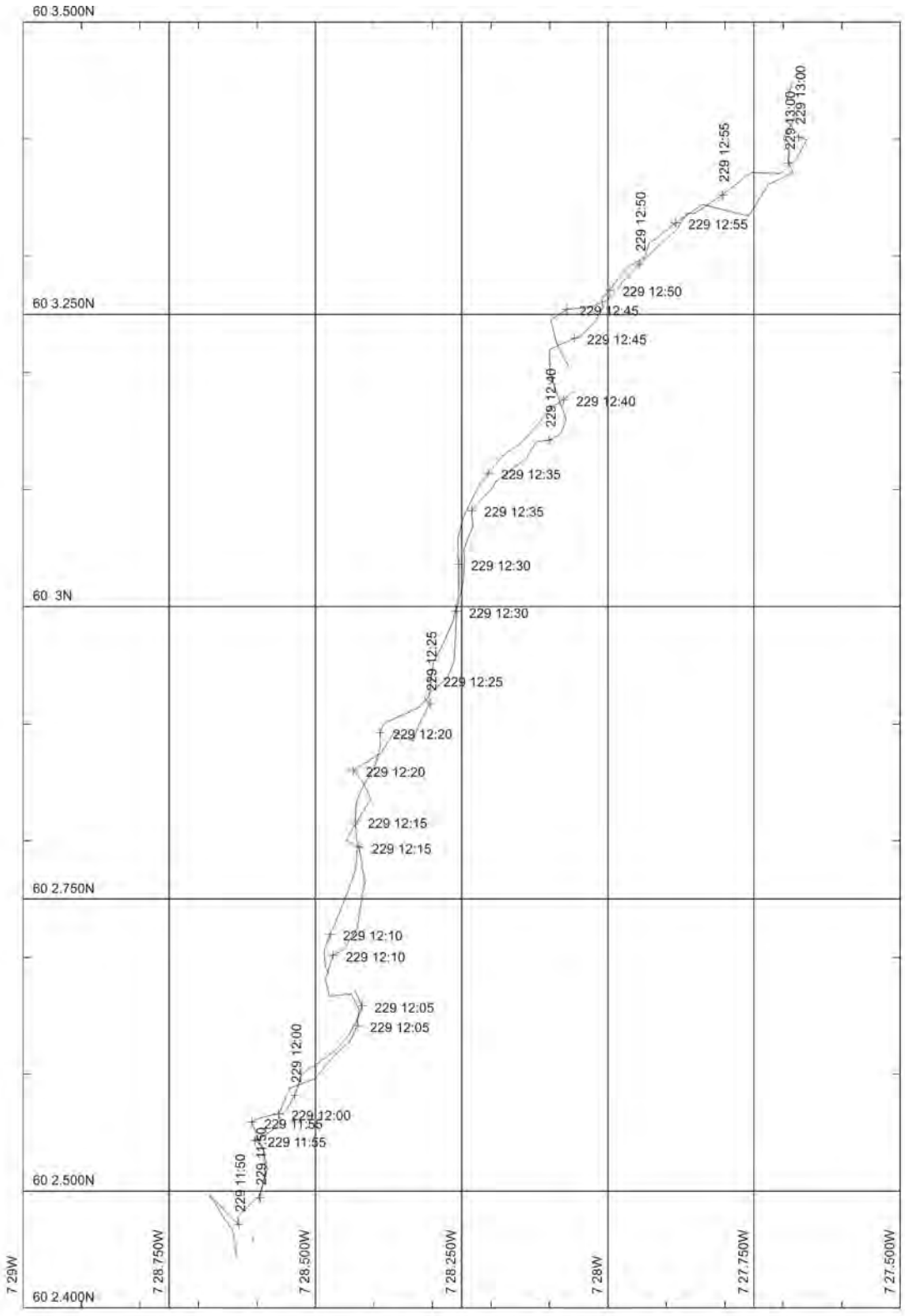

Chart 11. WASP 55010#1, Site W

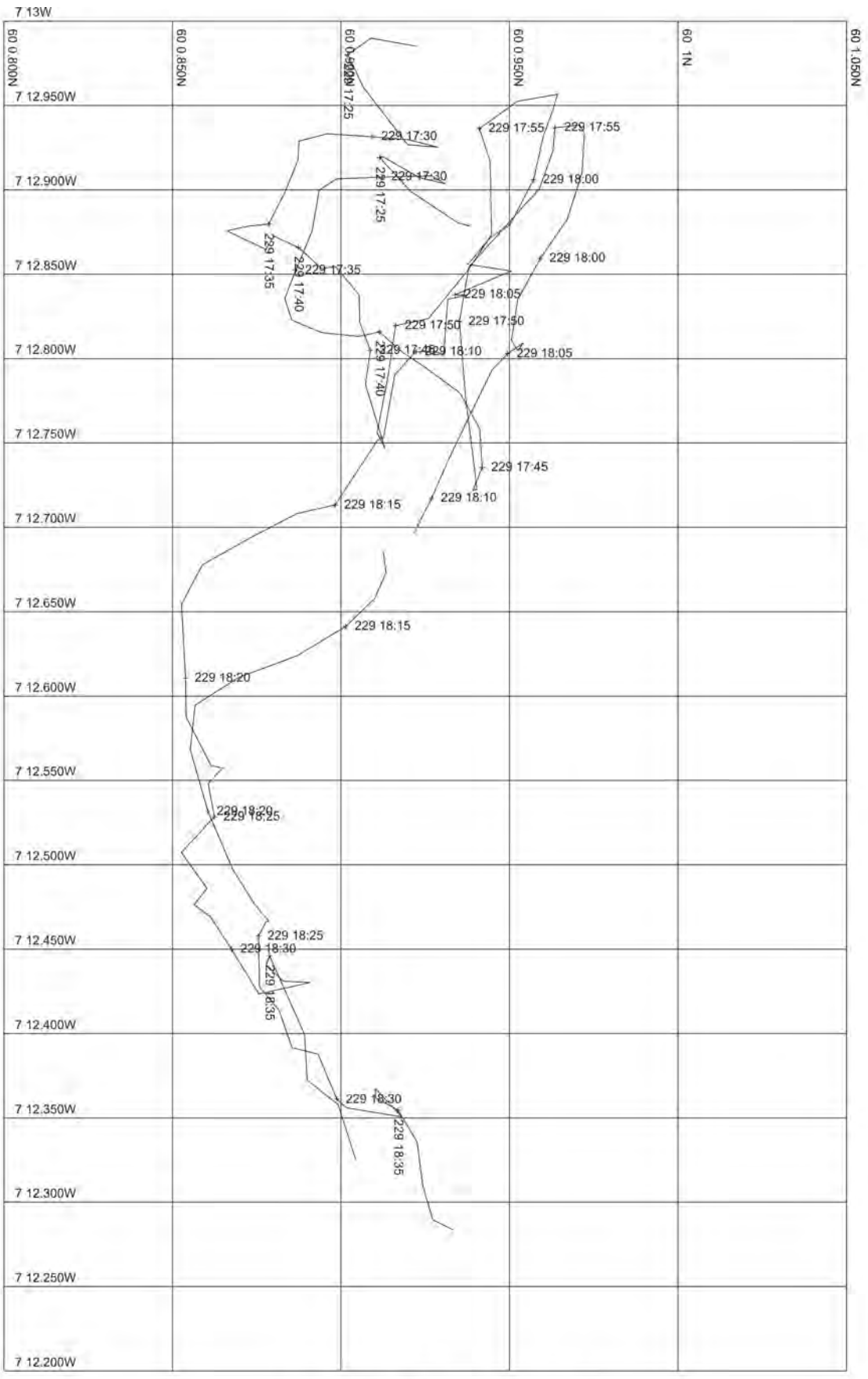

Chart 12. WASP 55011#1, Site E

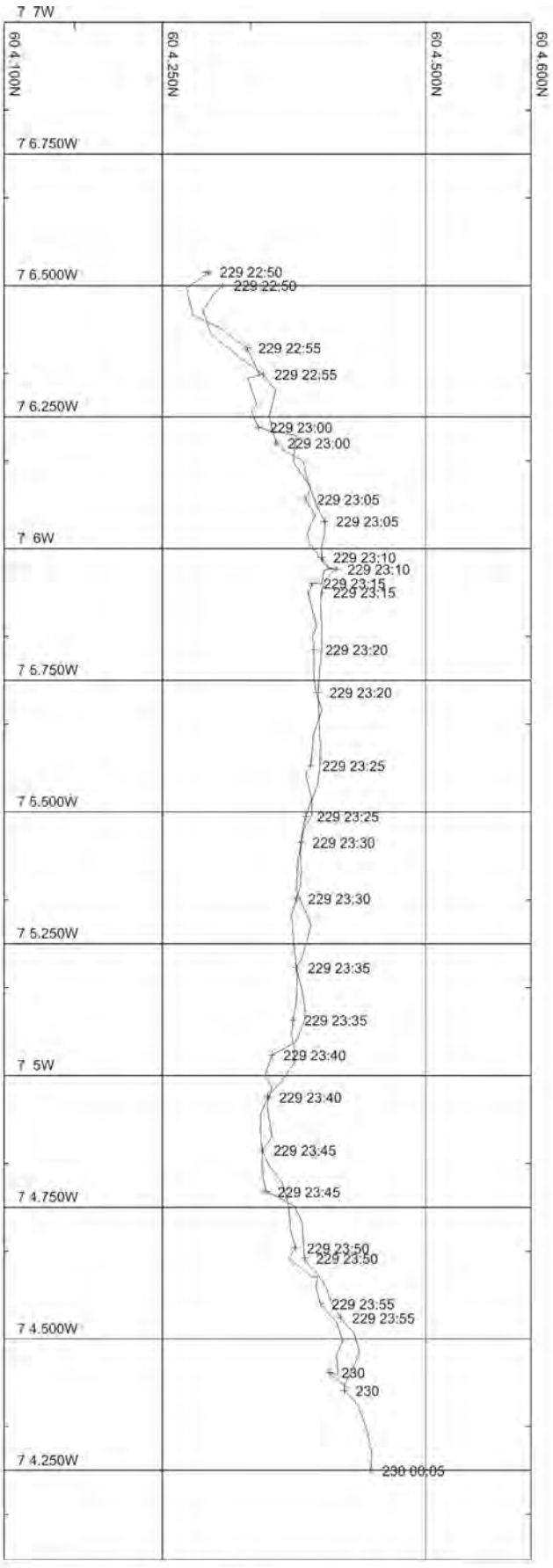

Chart 13. WASP 55012#4, Site FBC500

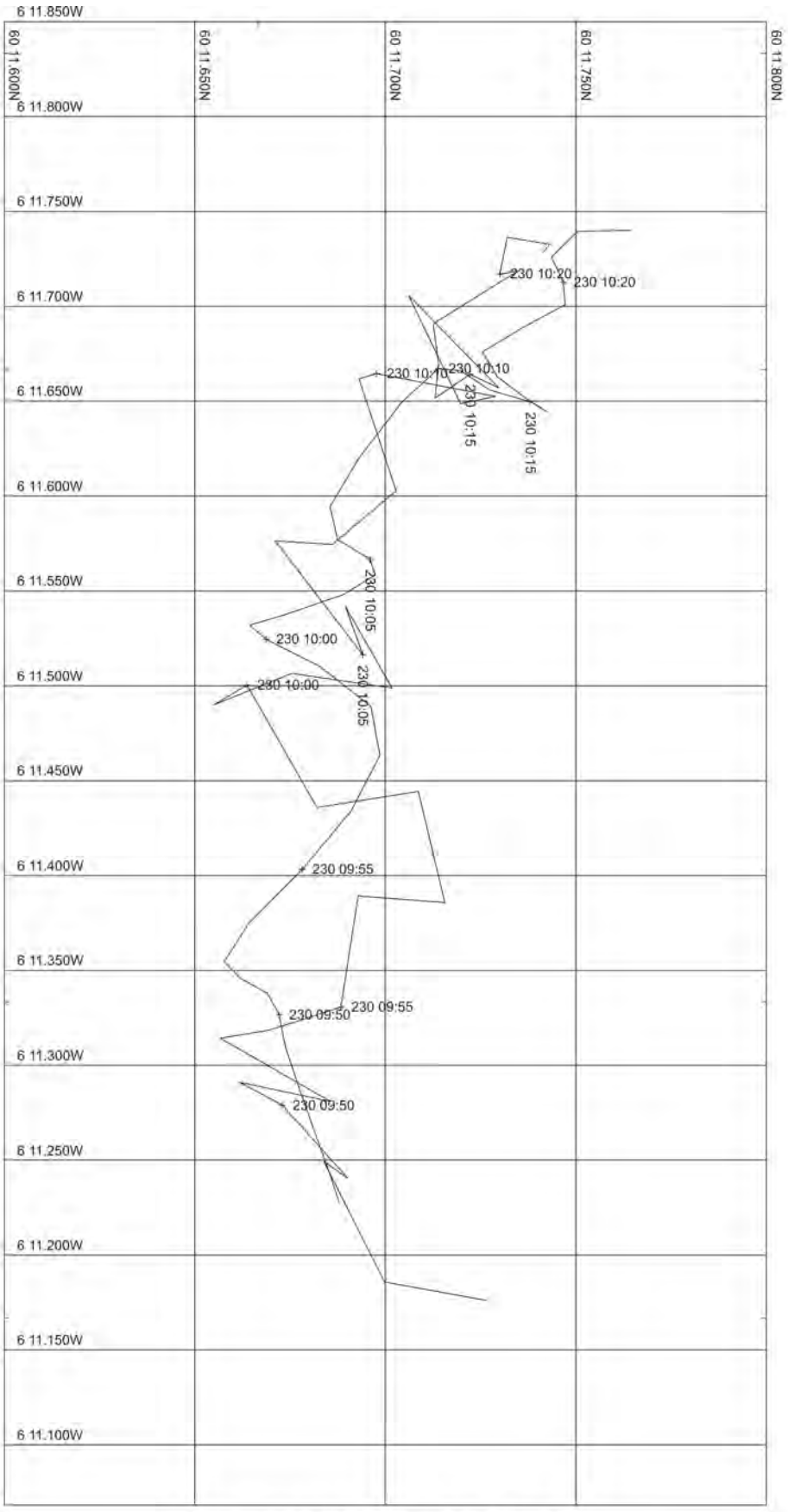

Chart 14. WASP 55014#2, Site N2

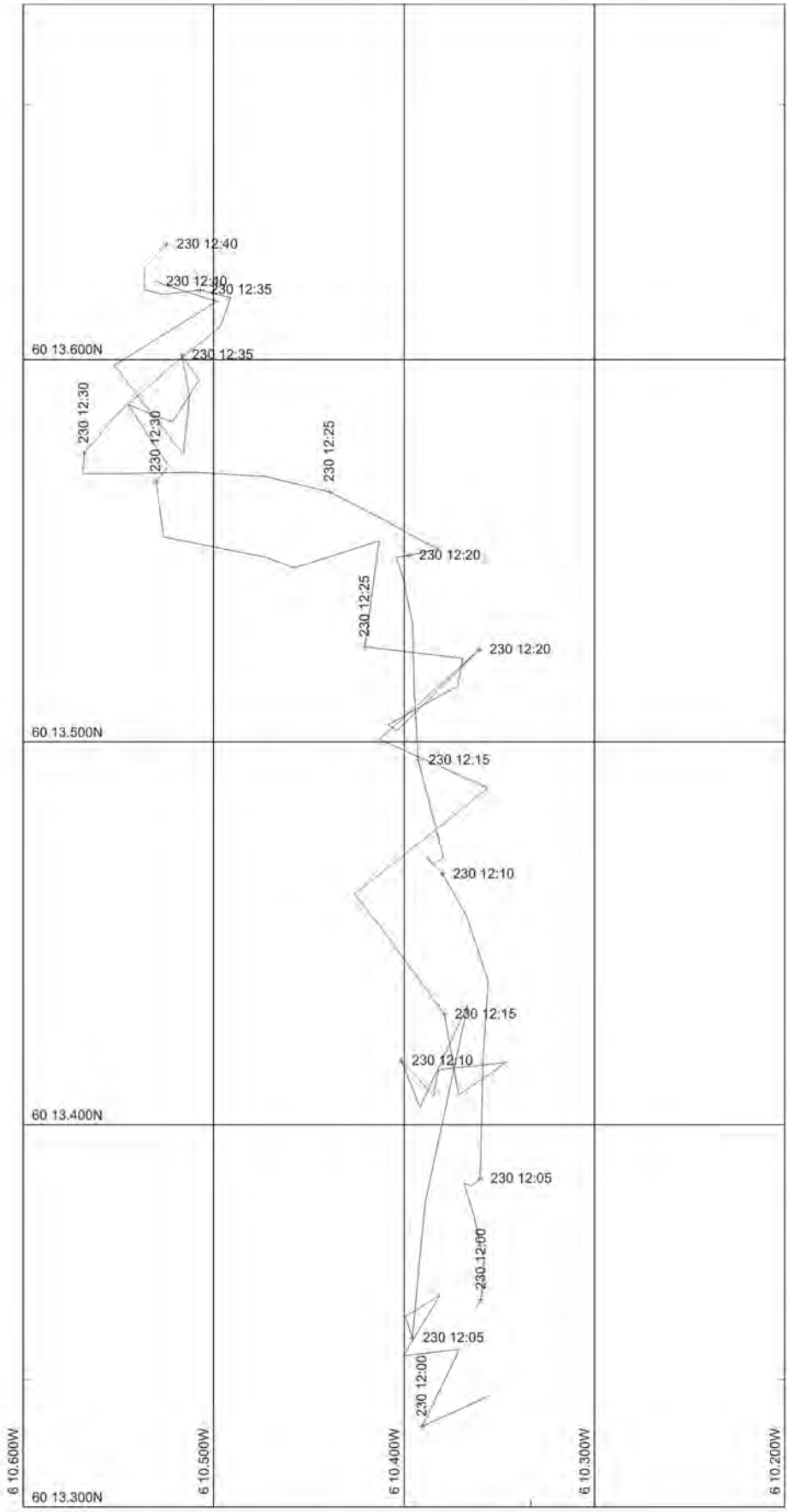

Chart 15. WASP 55015#1, Site N1

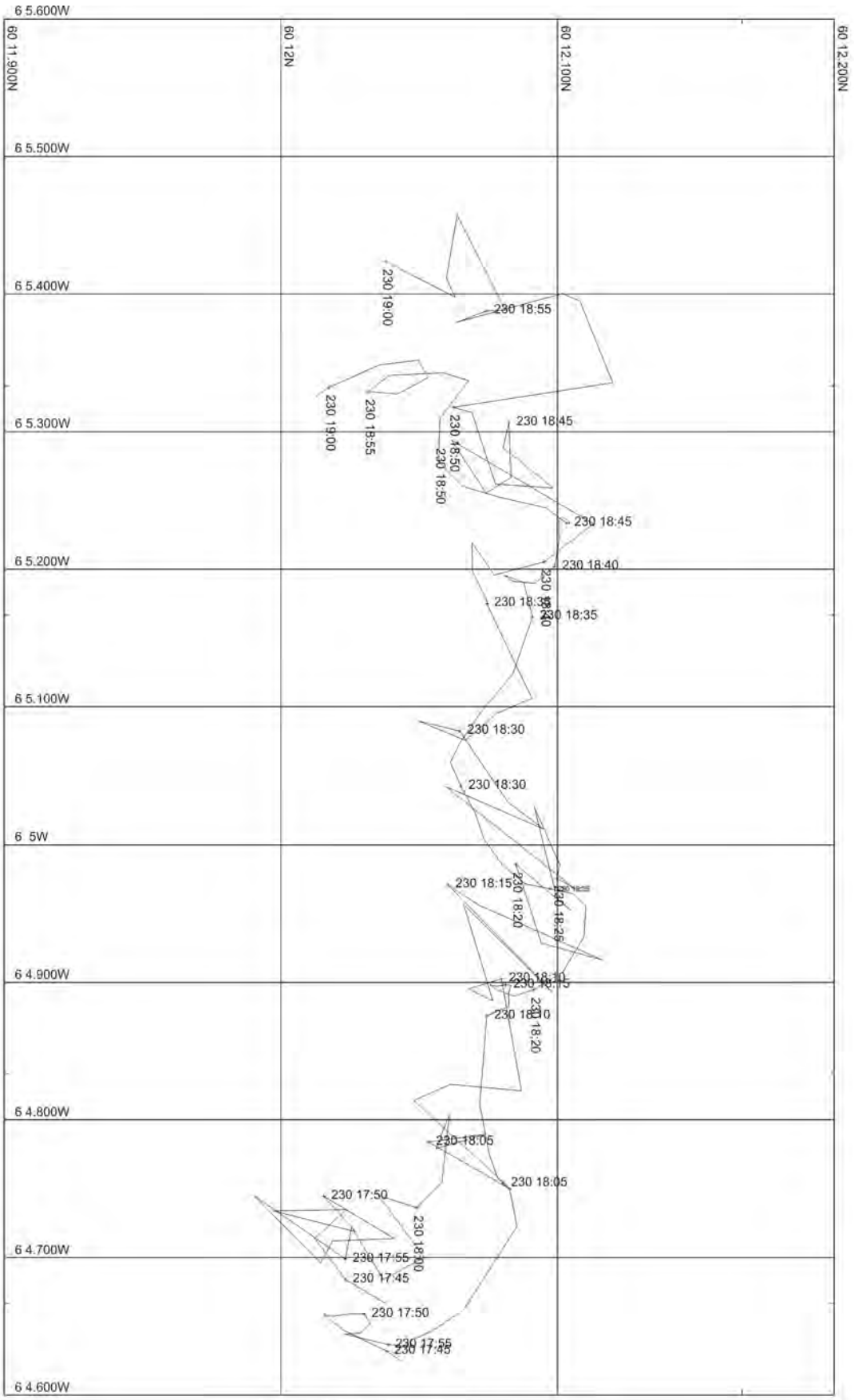

Chart 16. WASP 55016#1, Site P

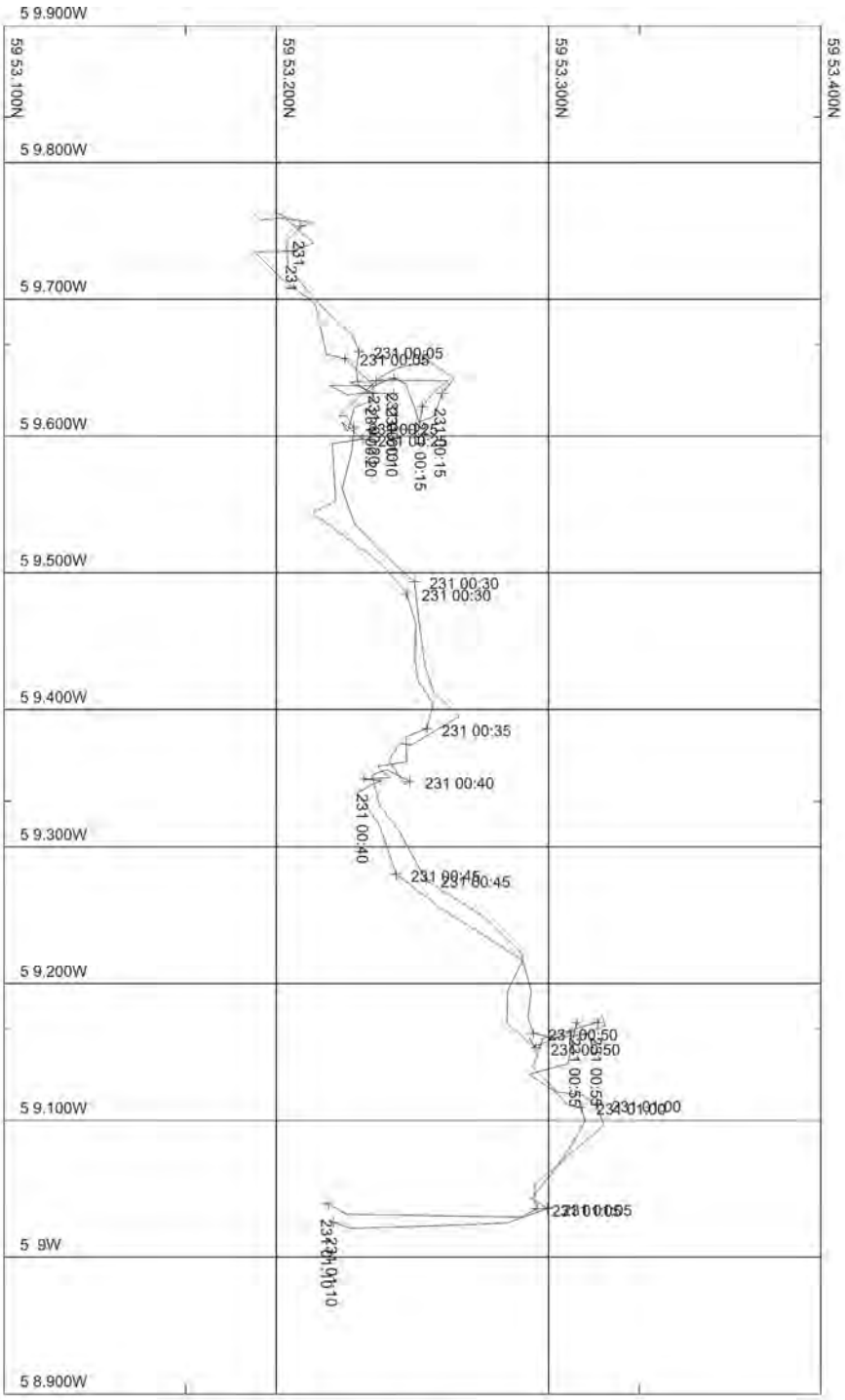

Chart 17. WASP 55017#1, Site FSC300

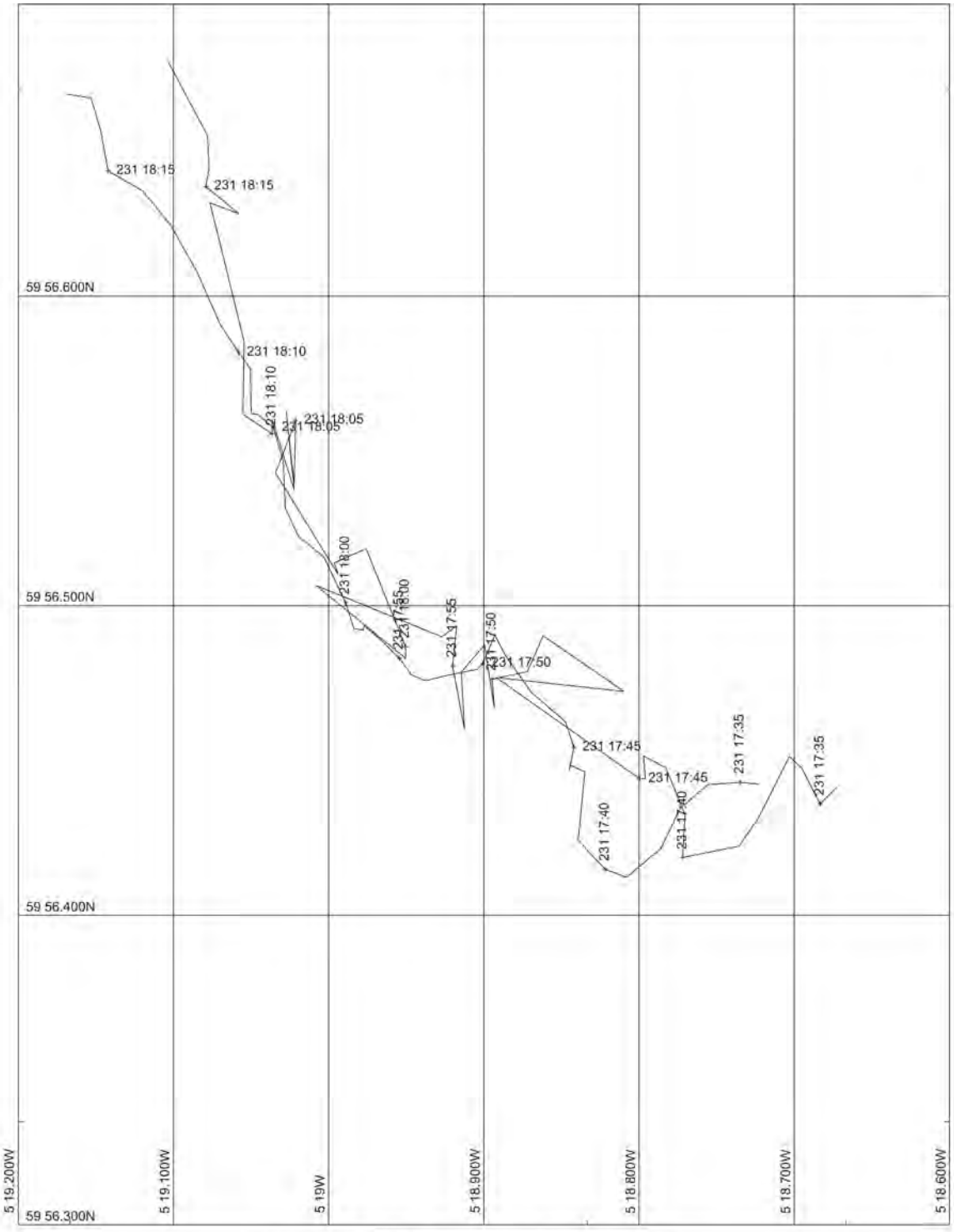

Chart 18. WASP 55018#2, Site FSC500

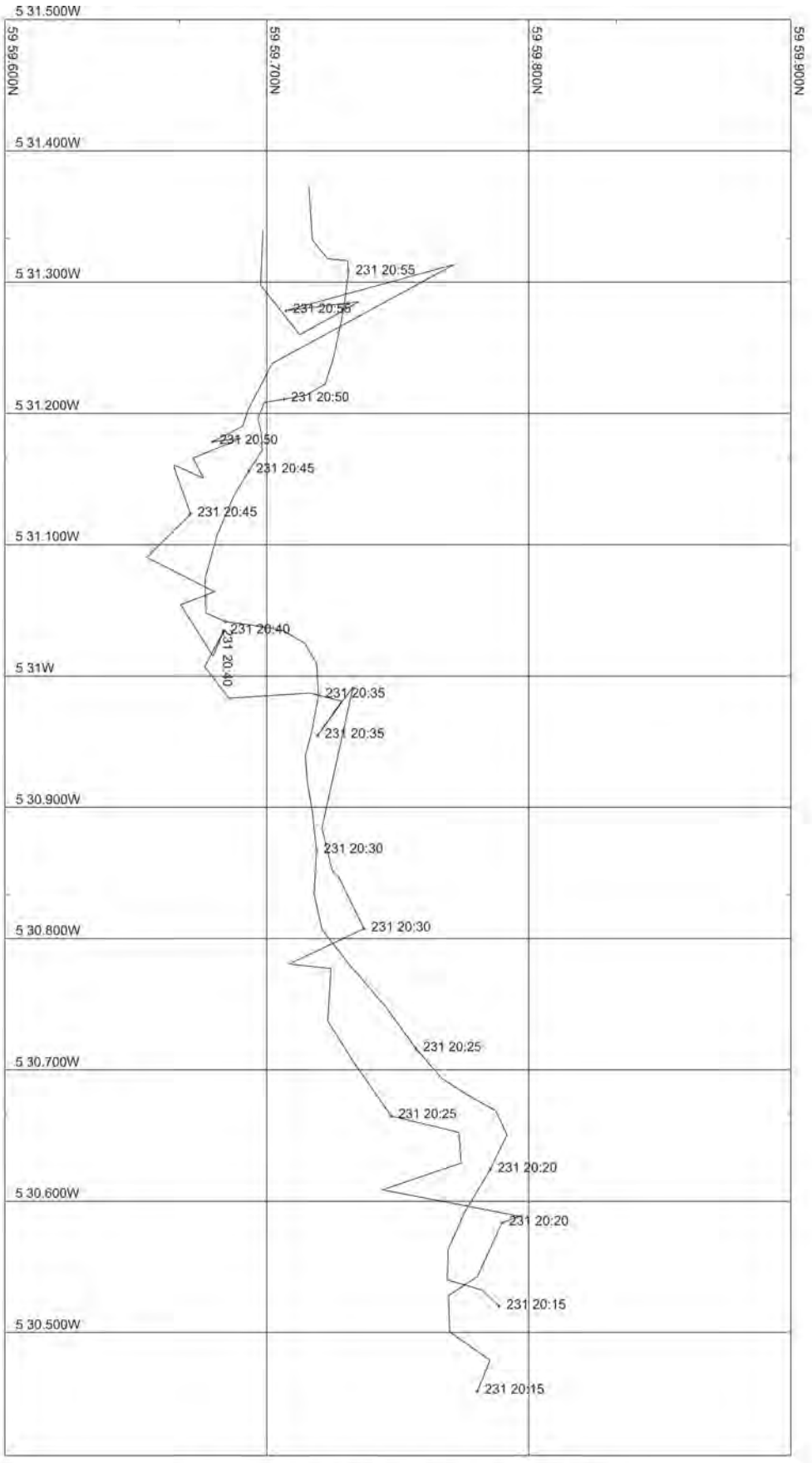

Chart 19. WASP 55019#1, Site FSC800

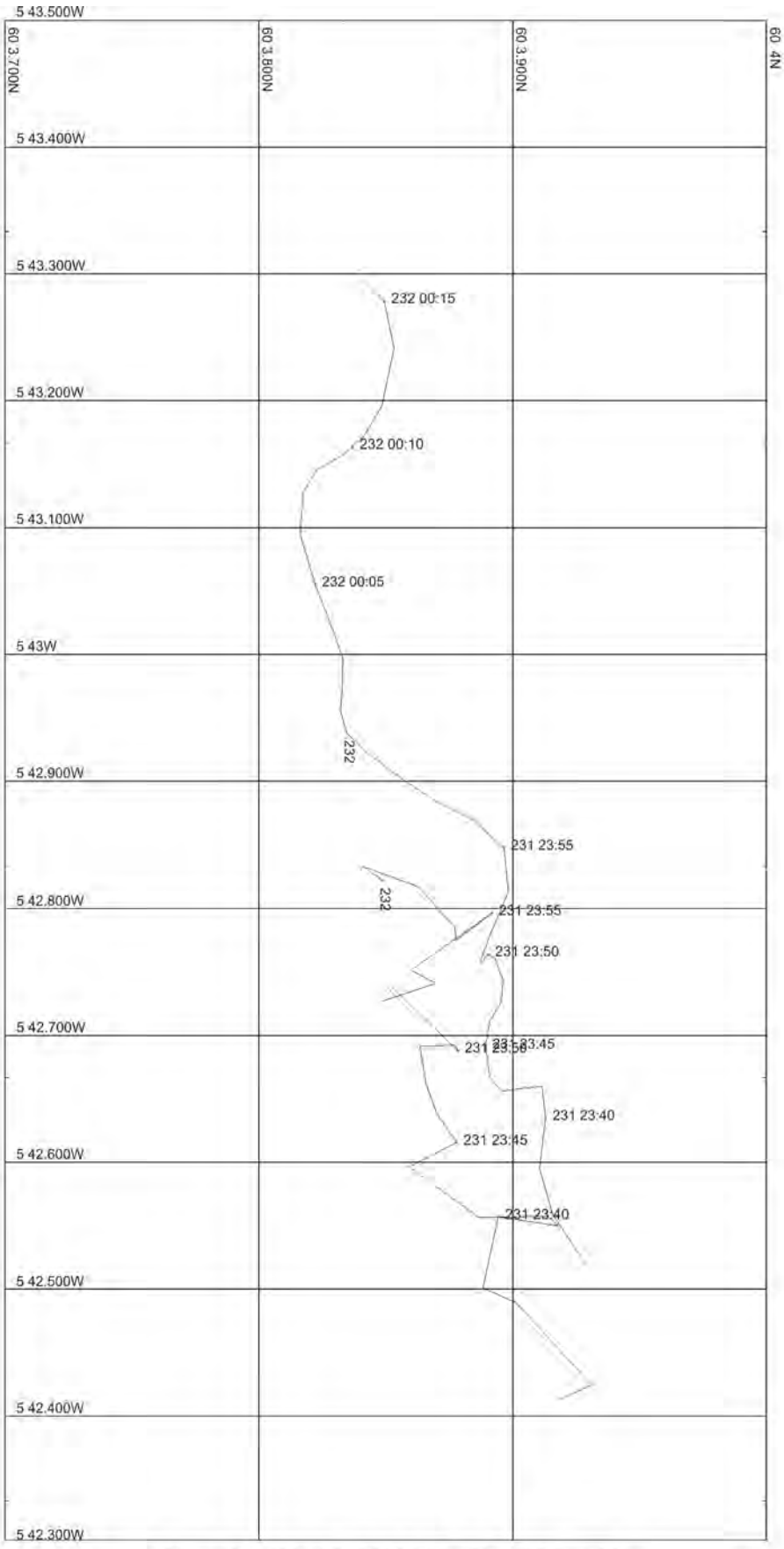

Chart 20. WASP 55020#1, Site FSC1000

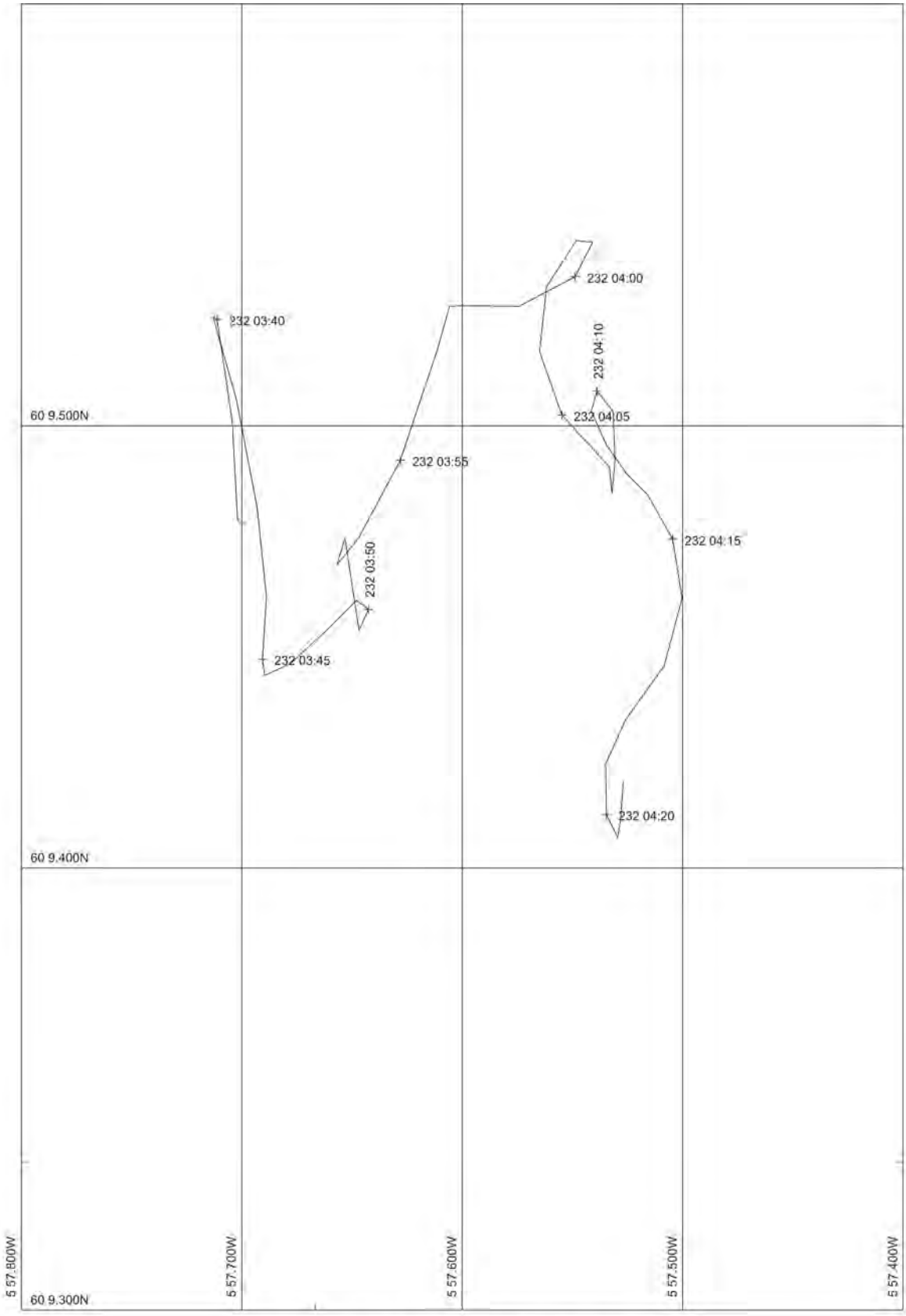

Chart 21. WASP 55021#1, Site FSC1200

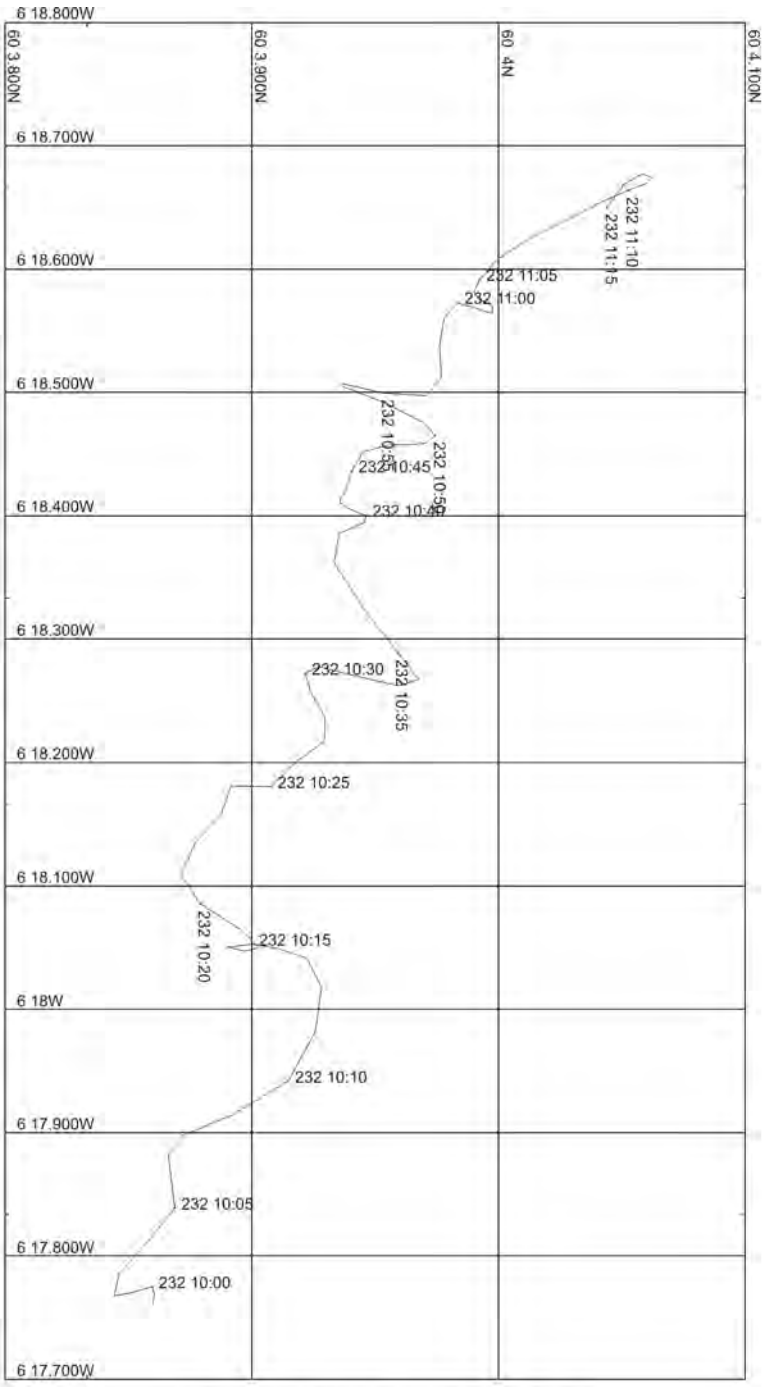

Chart 22. WASP 55022#1, Site L

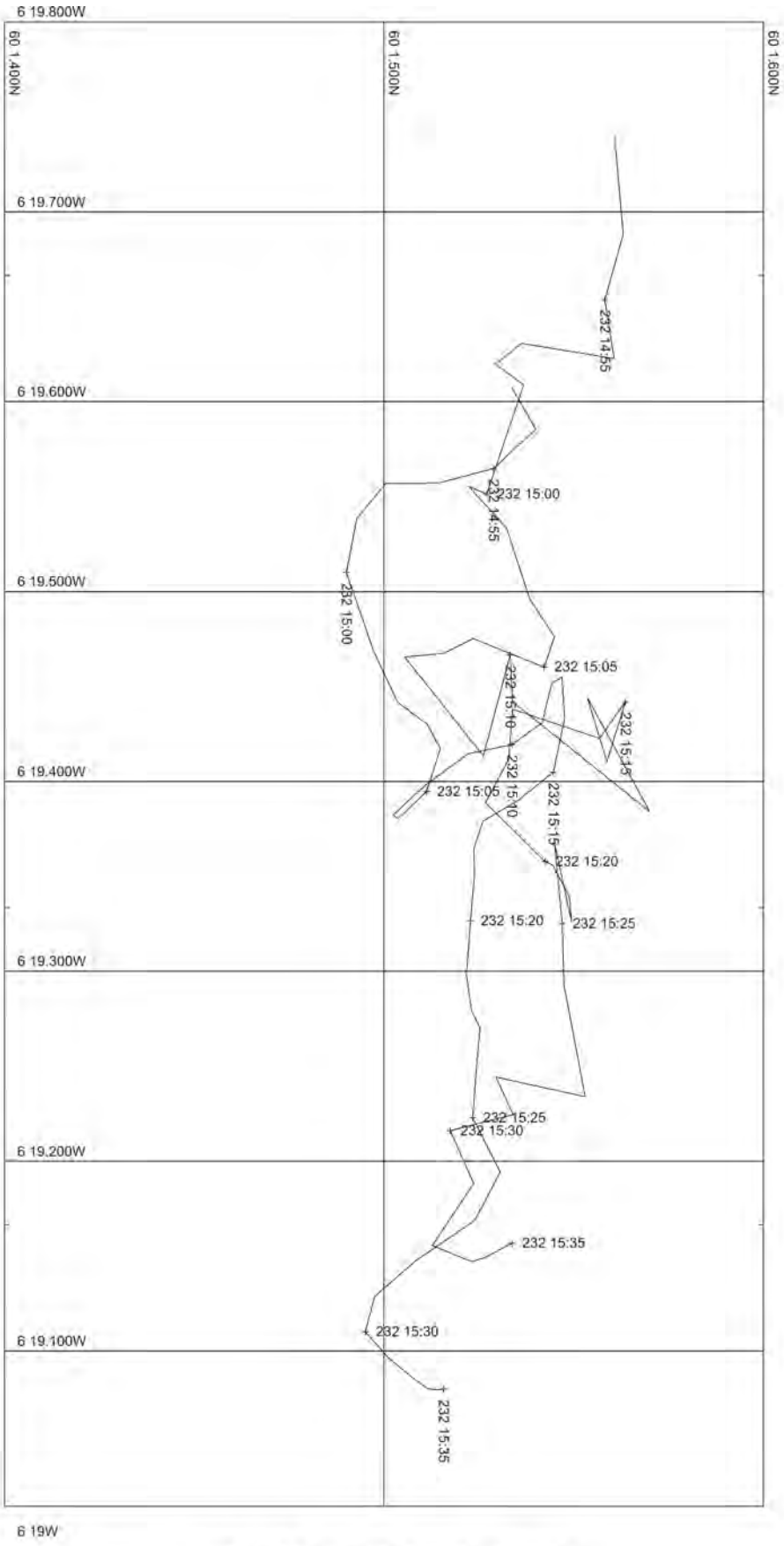

Chart 23. WASP 55023#1, Site J

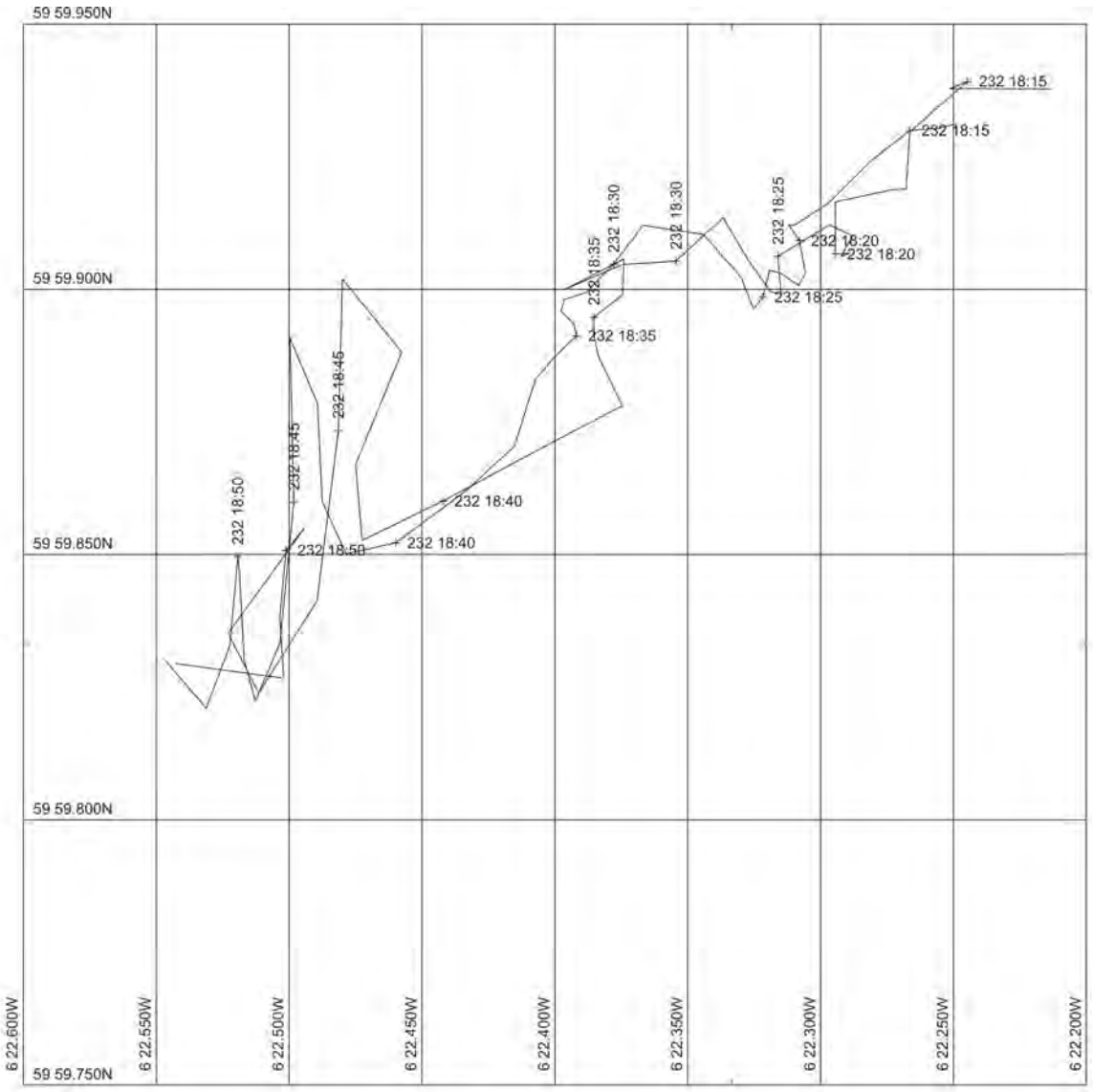

Chart 24. WASP 55024#1, Site K

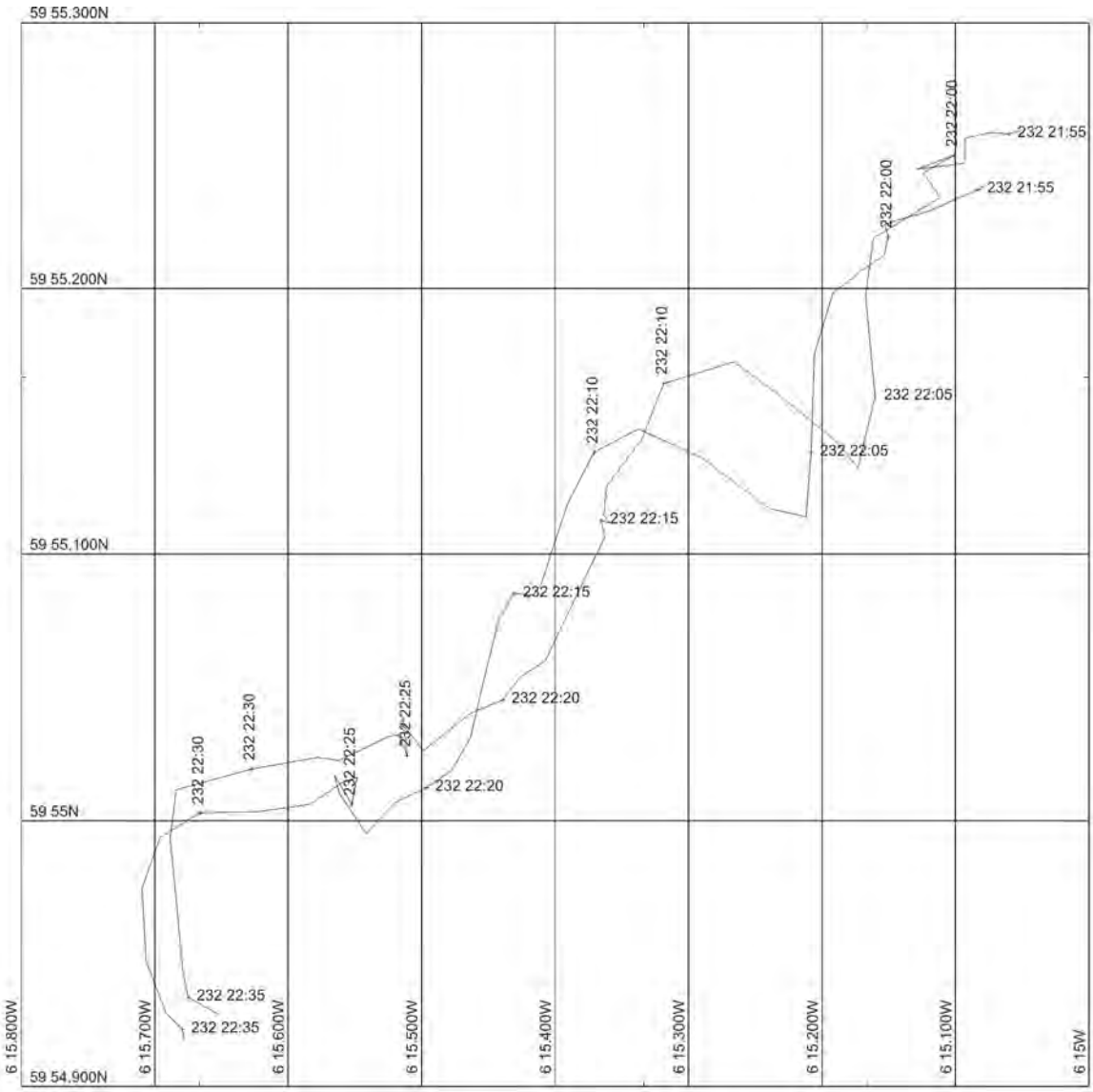

Chart 25. WASP 55025#1, Site G1

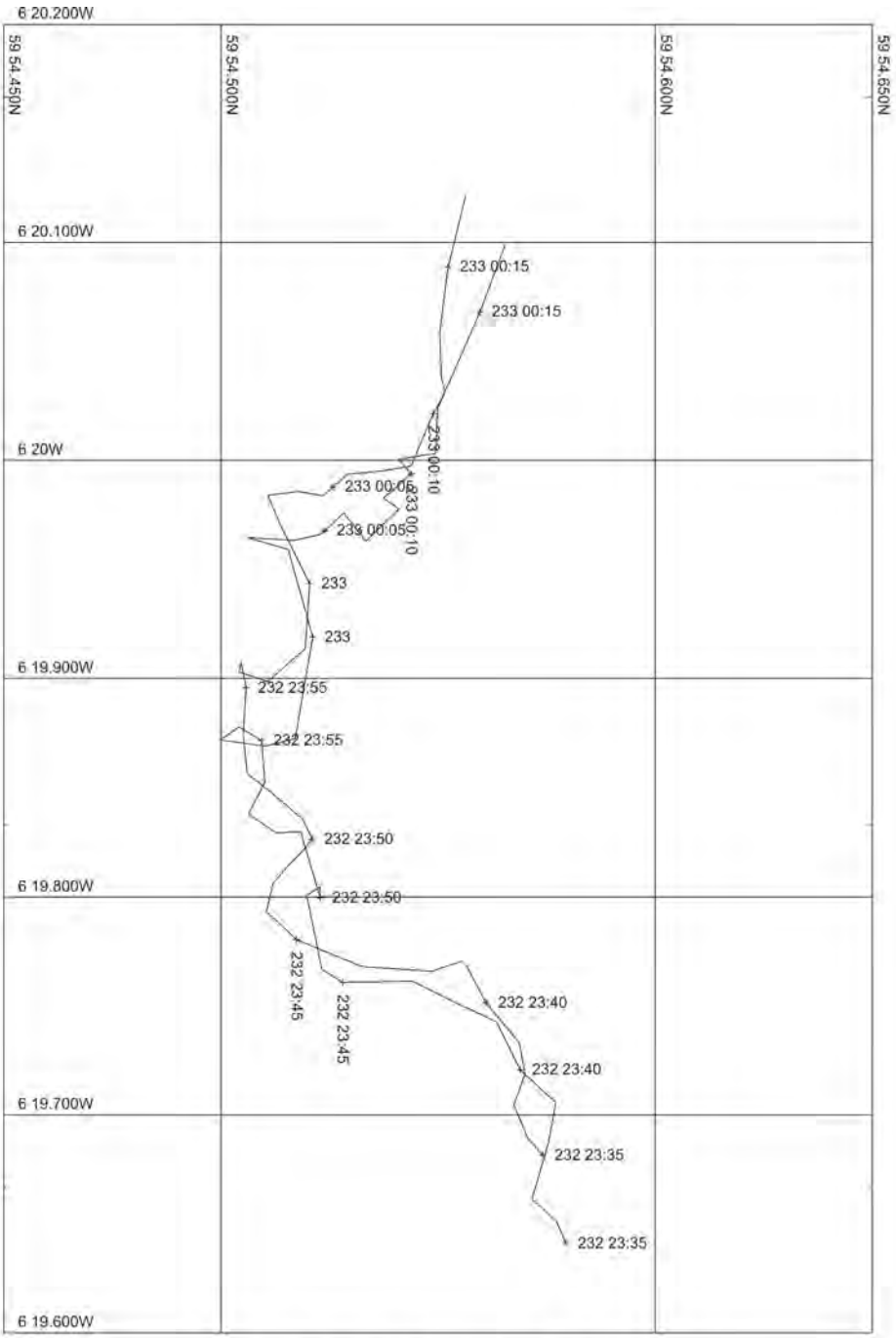

Chart 26. WASP 55026#1, Site G2

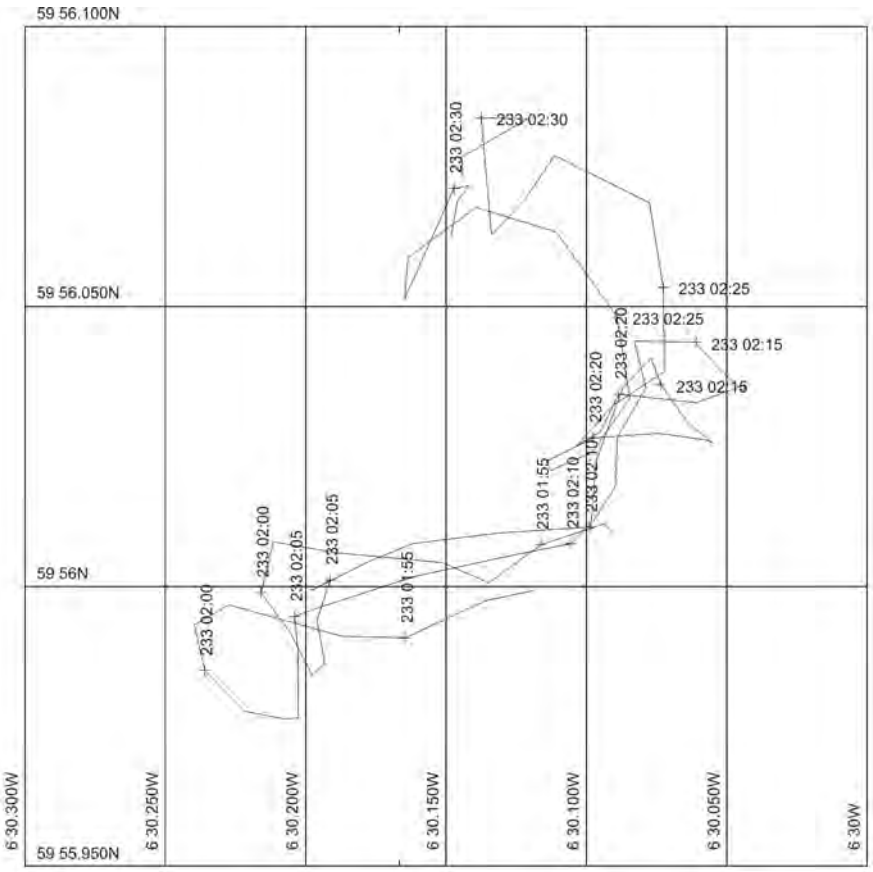

Chart 27. WASP 55027#1, Site V

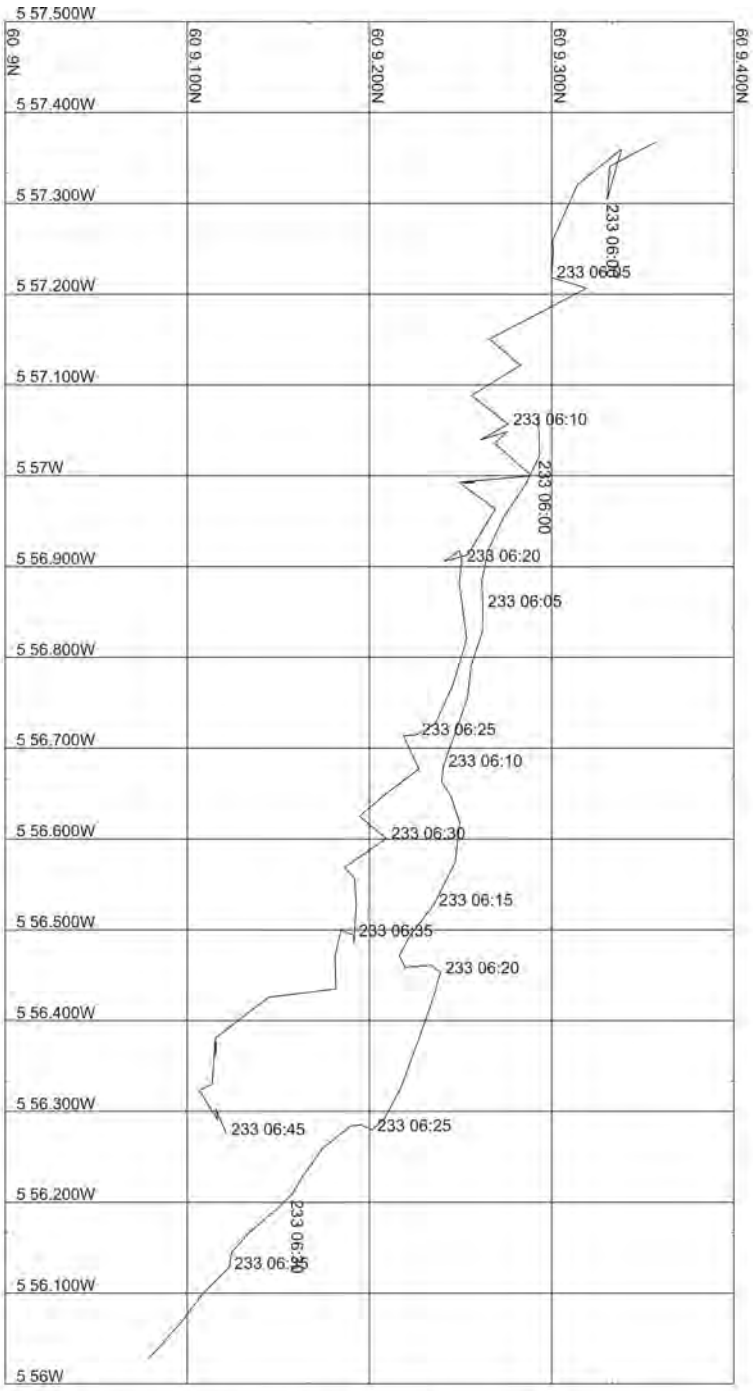

Chart 28. WASP 55028#1, Site FSC1200

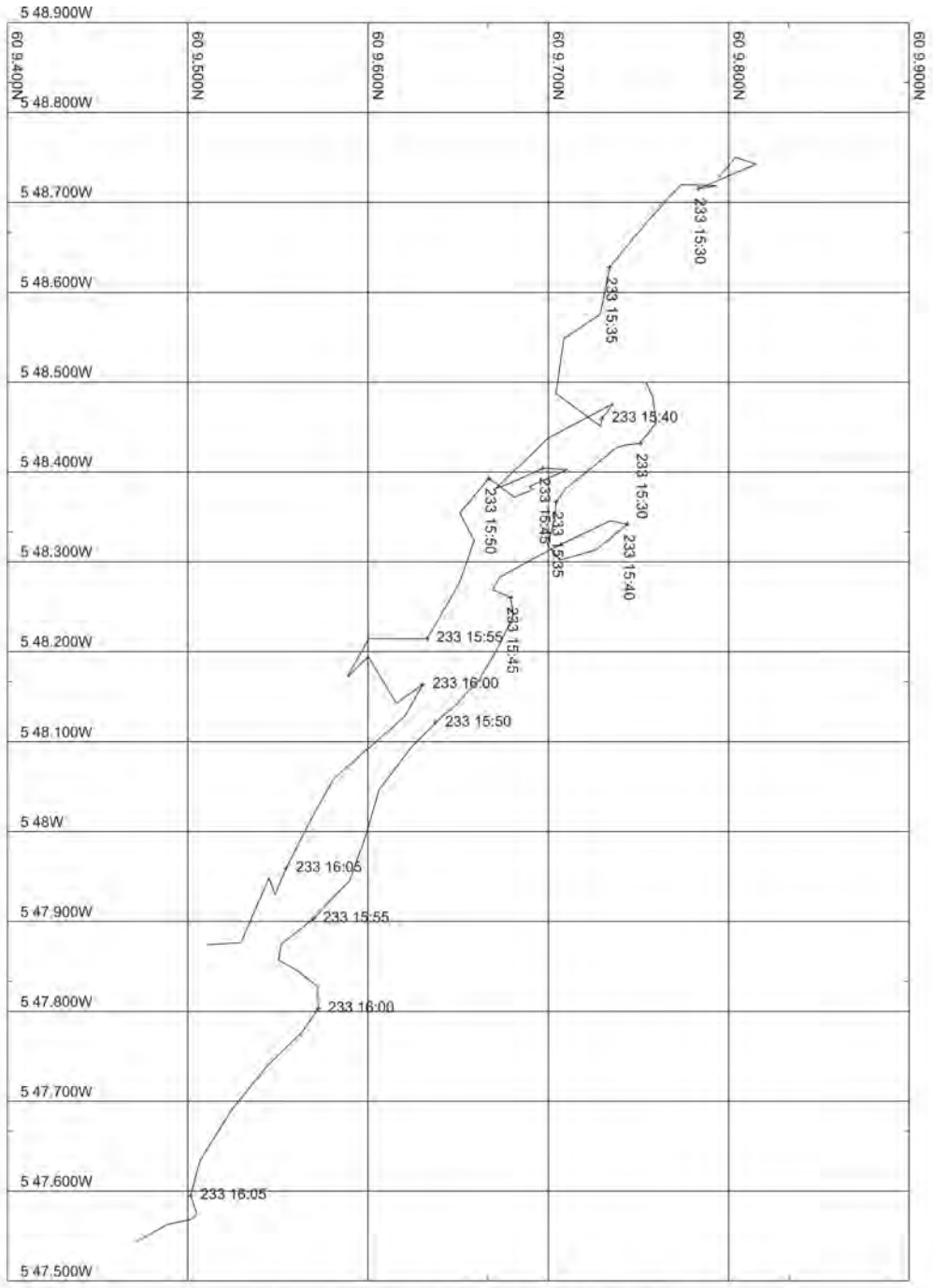

Chart 29. WASP 55030#1, Site R1

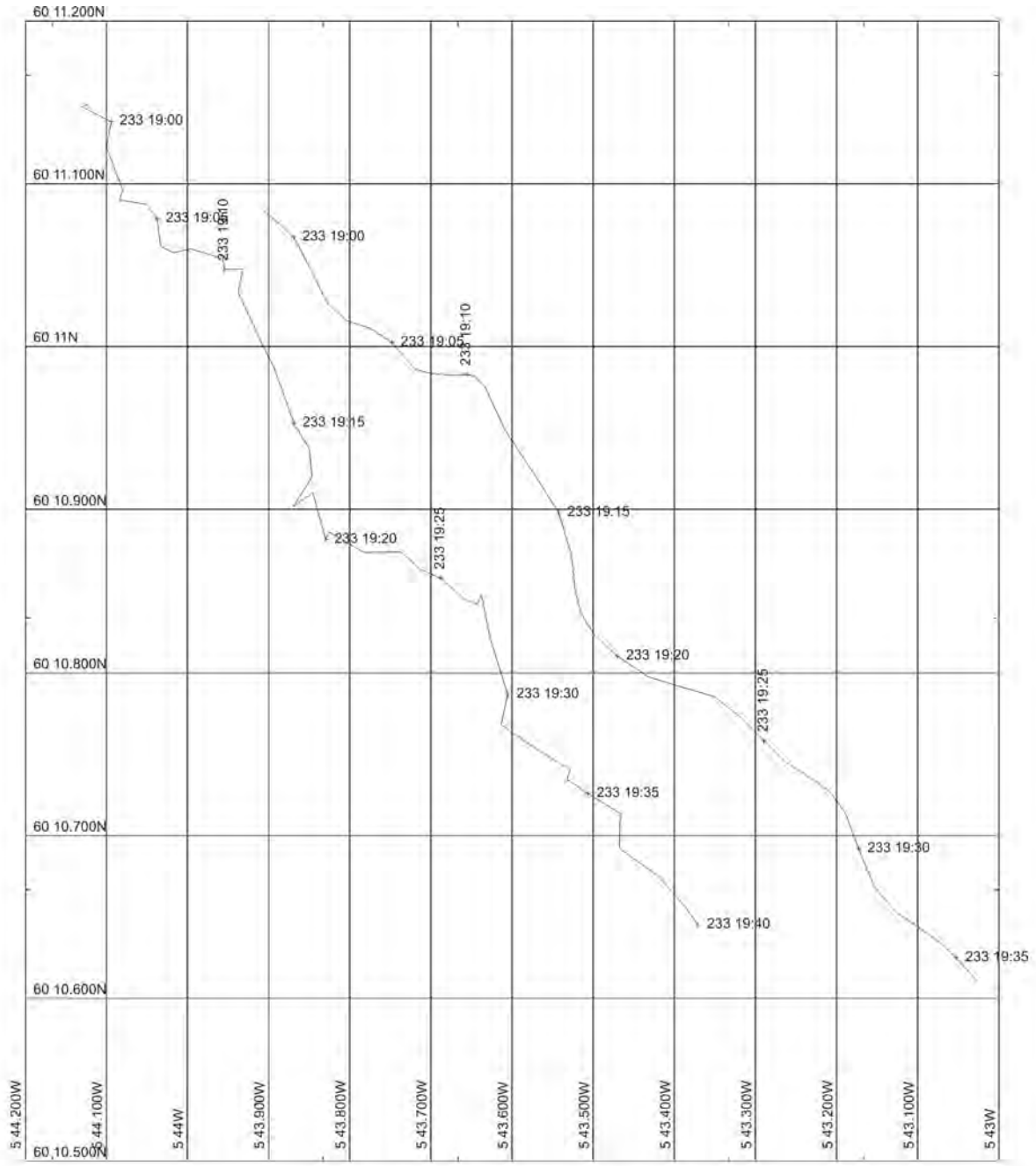

Chart 30. WASP 55031#1, Site R2

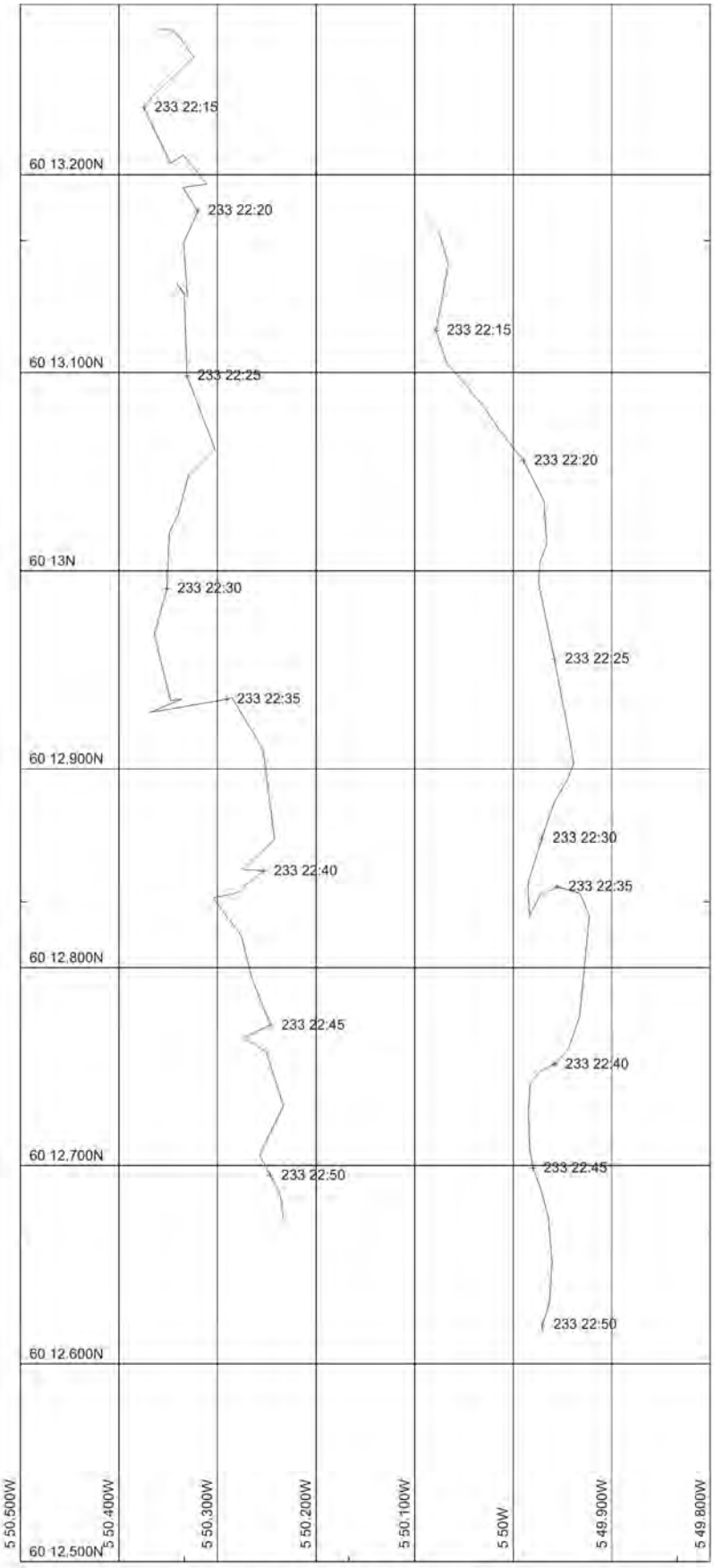

Chart 31. WASP 55032#1, Site Q

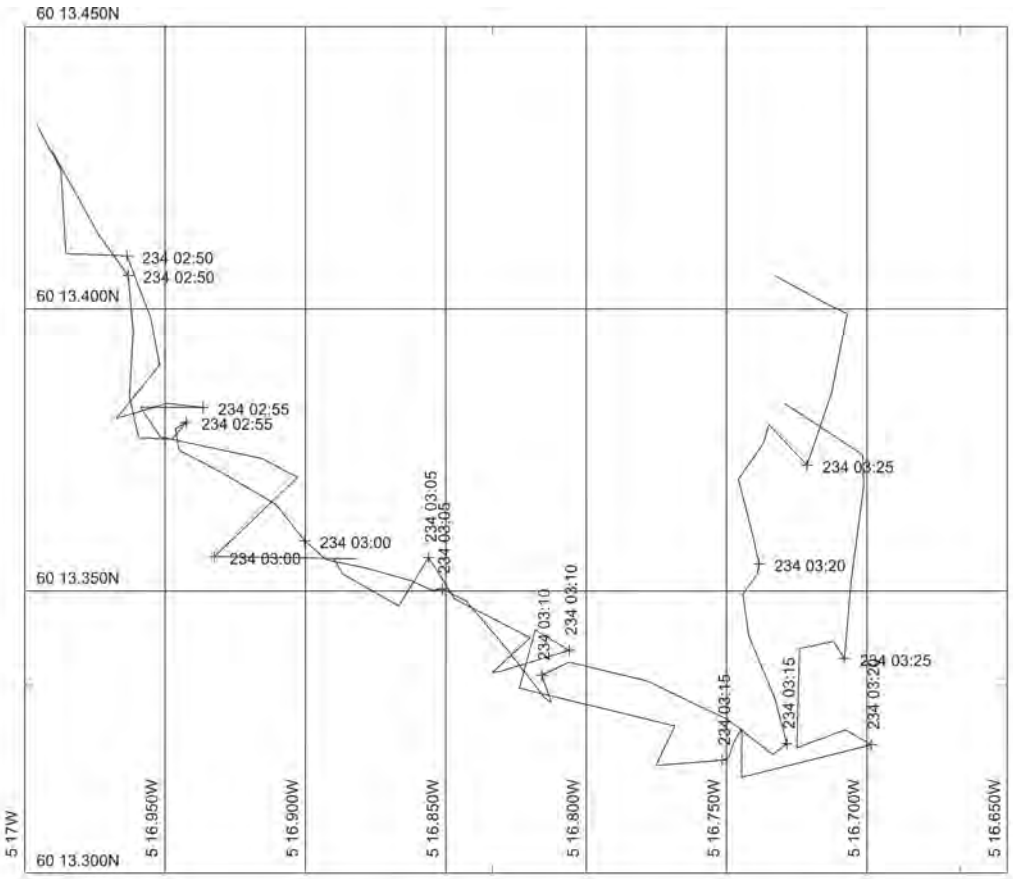

Chart 32. WASP 55033#1, Site S

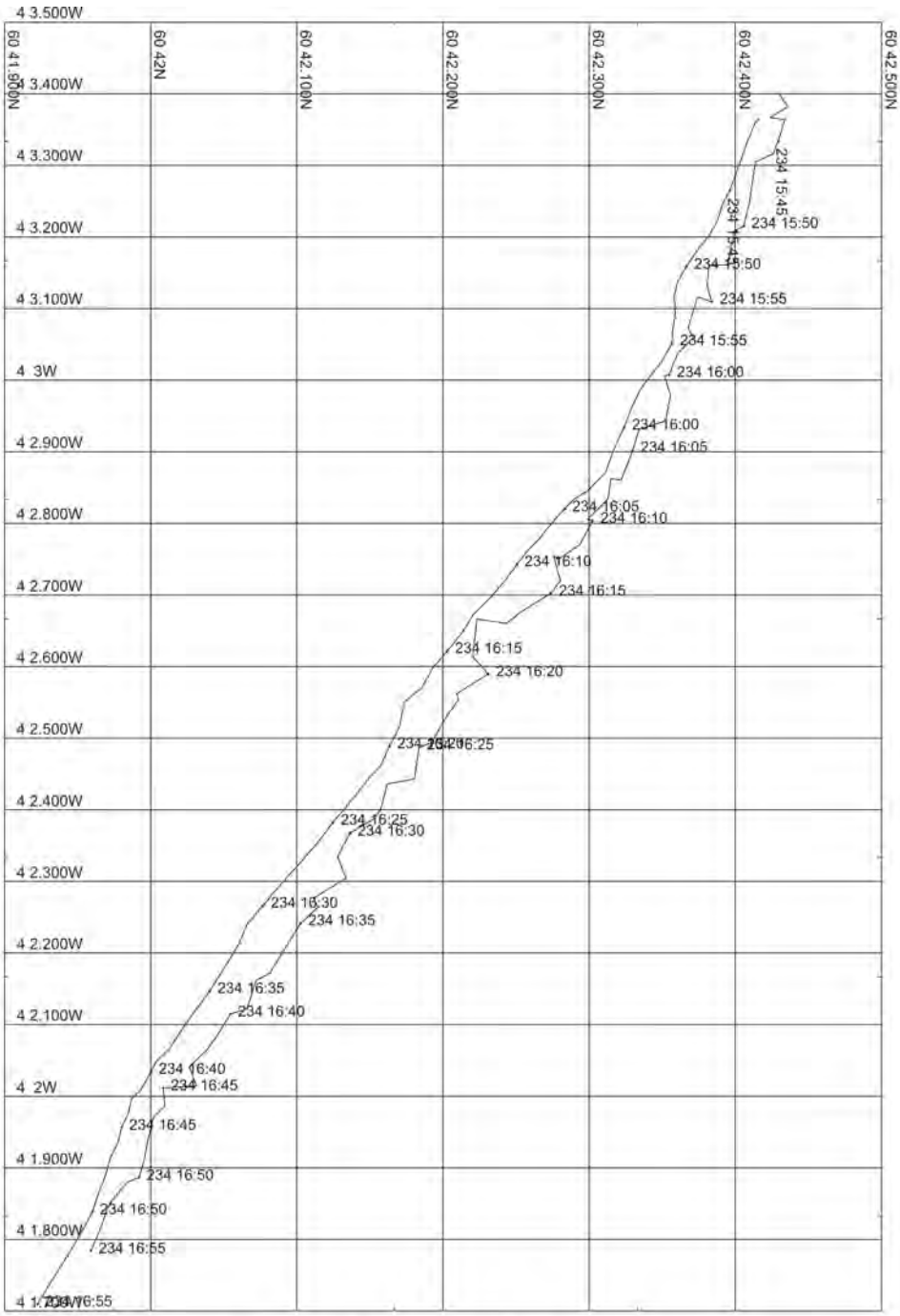

Chart 33. WASP 55035#1, Site X1

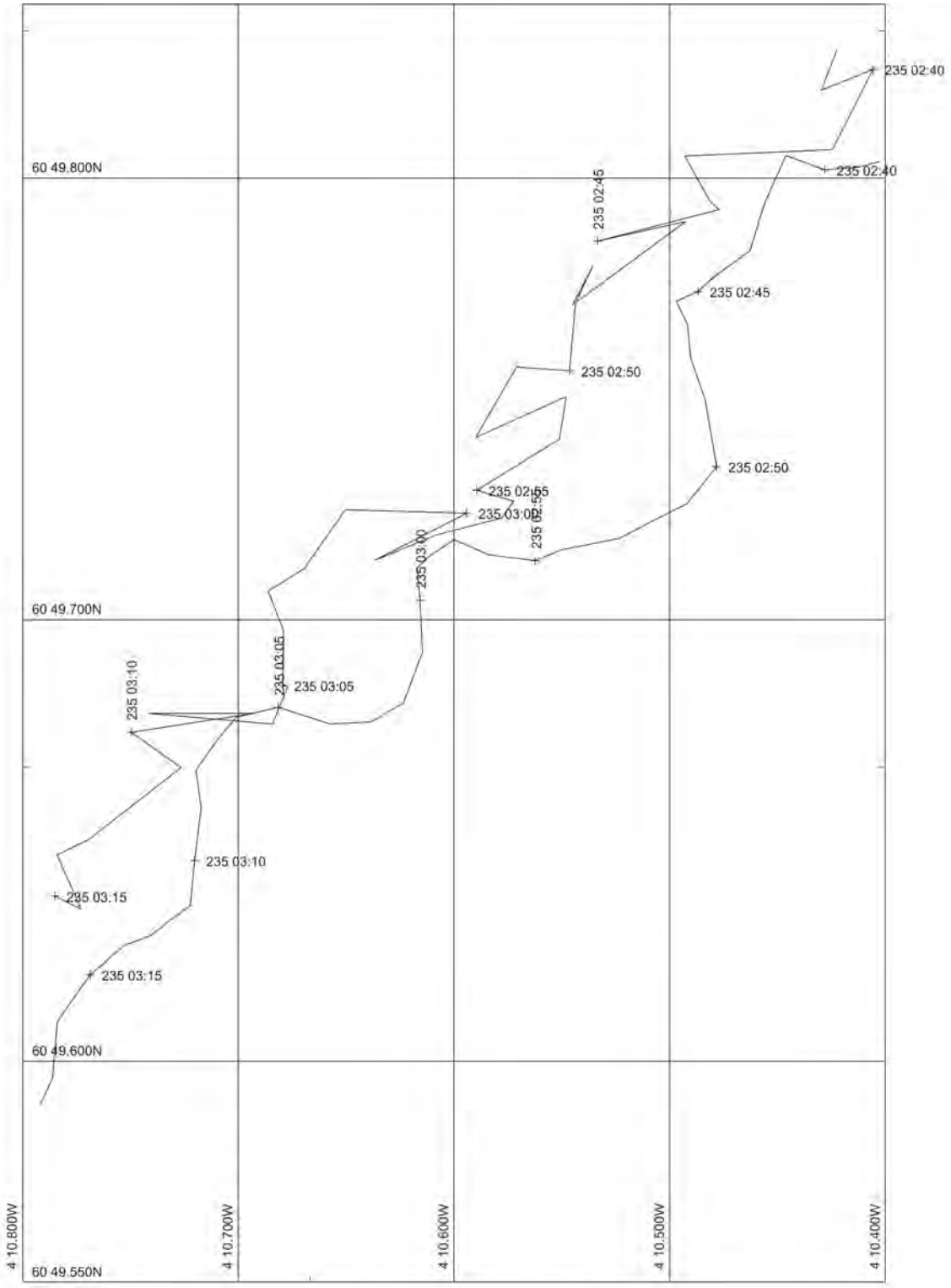

Chart 34. WASP 55038#1, Site X2

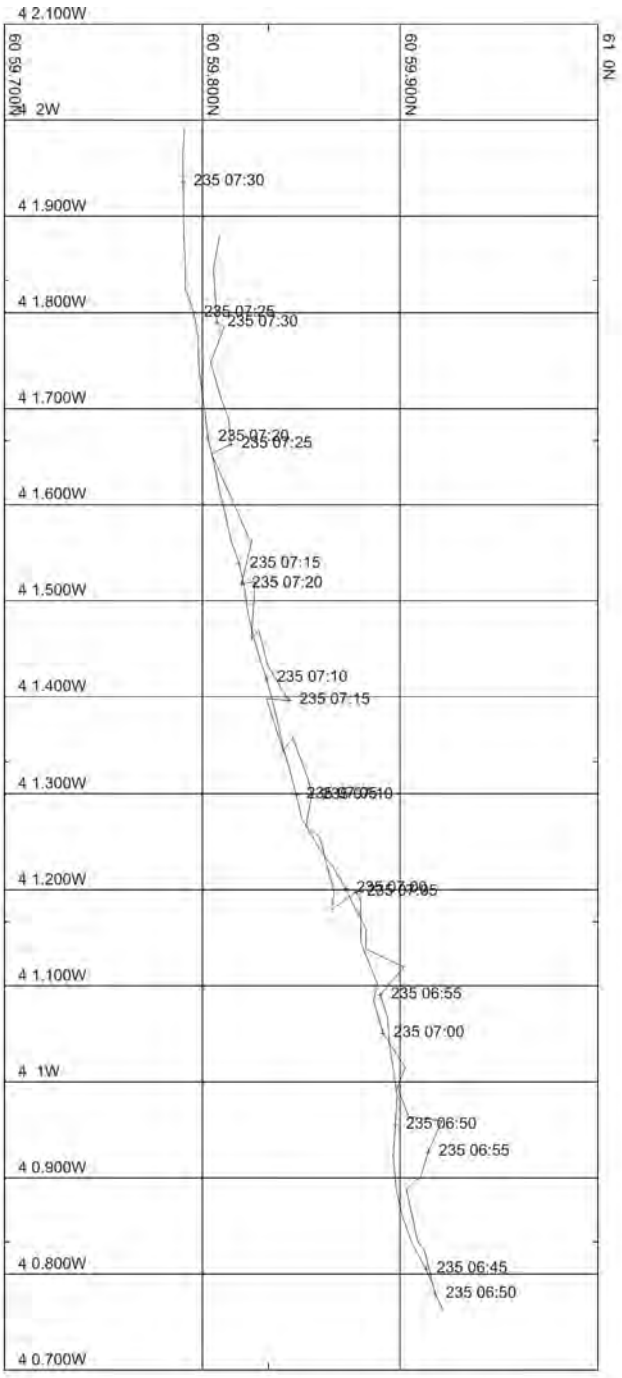

Chart 35. WASP 55039#1, Site X3

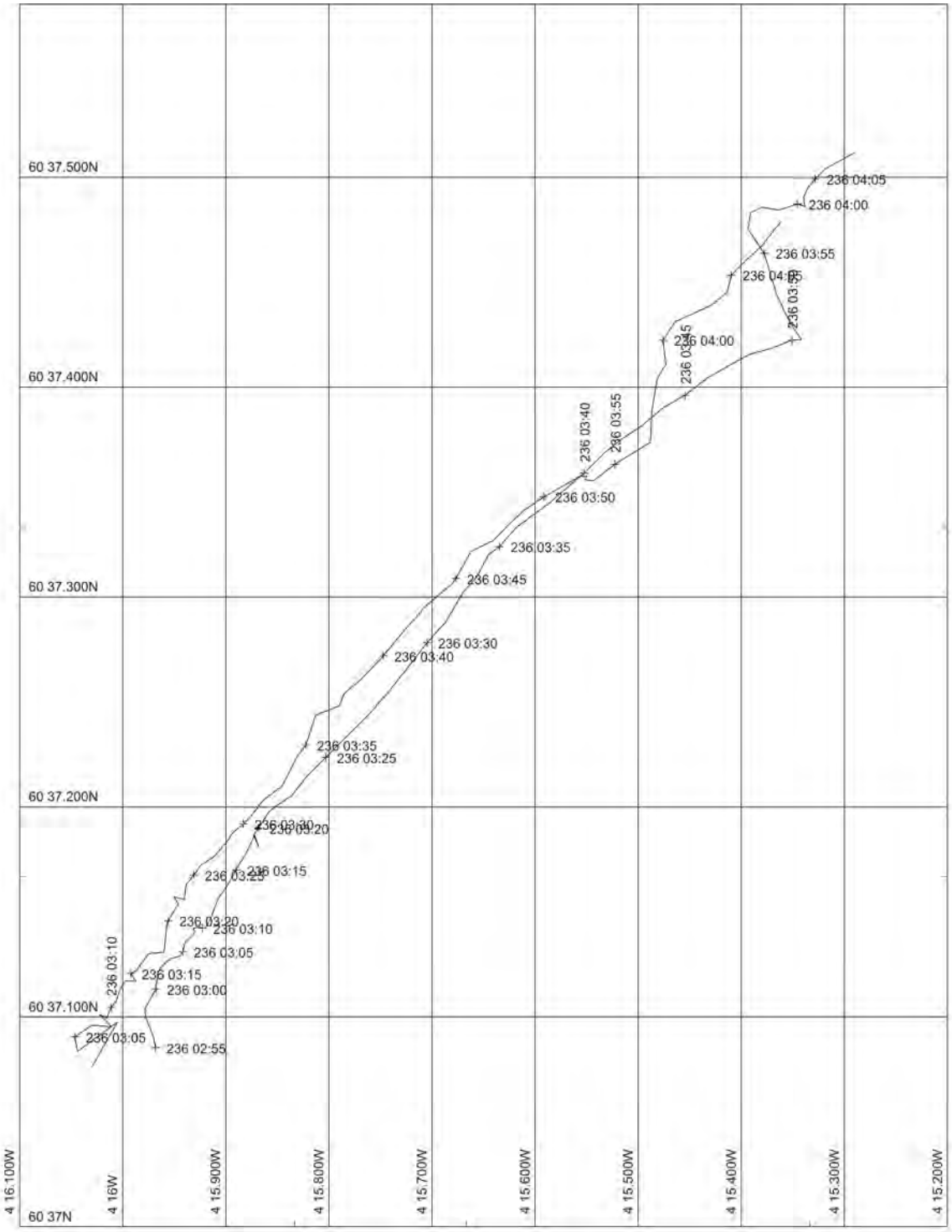

Chart 36. WASP 55043#1, Site Y1

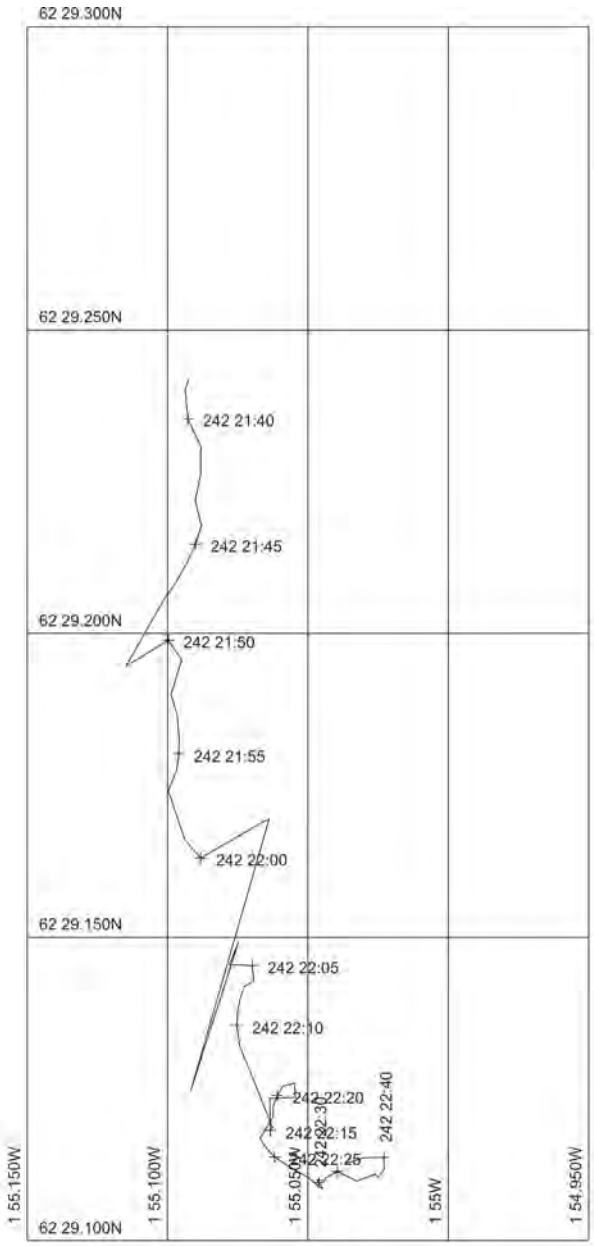

Chart 37. WASP 55045#1, Site FPS1800

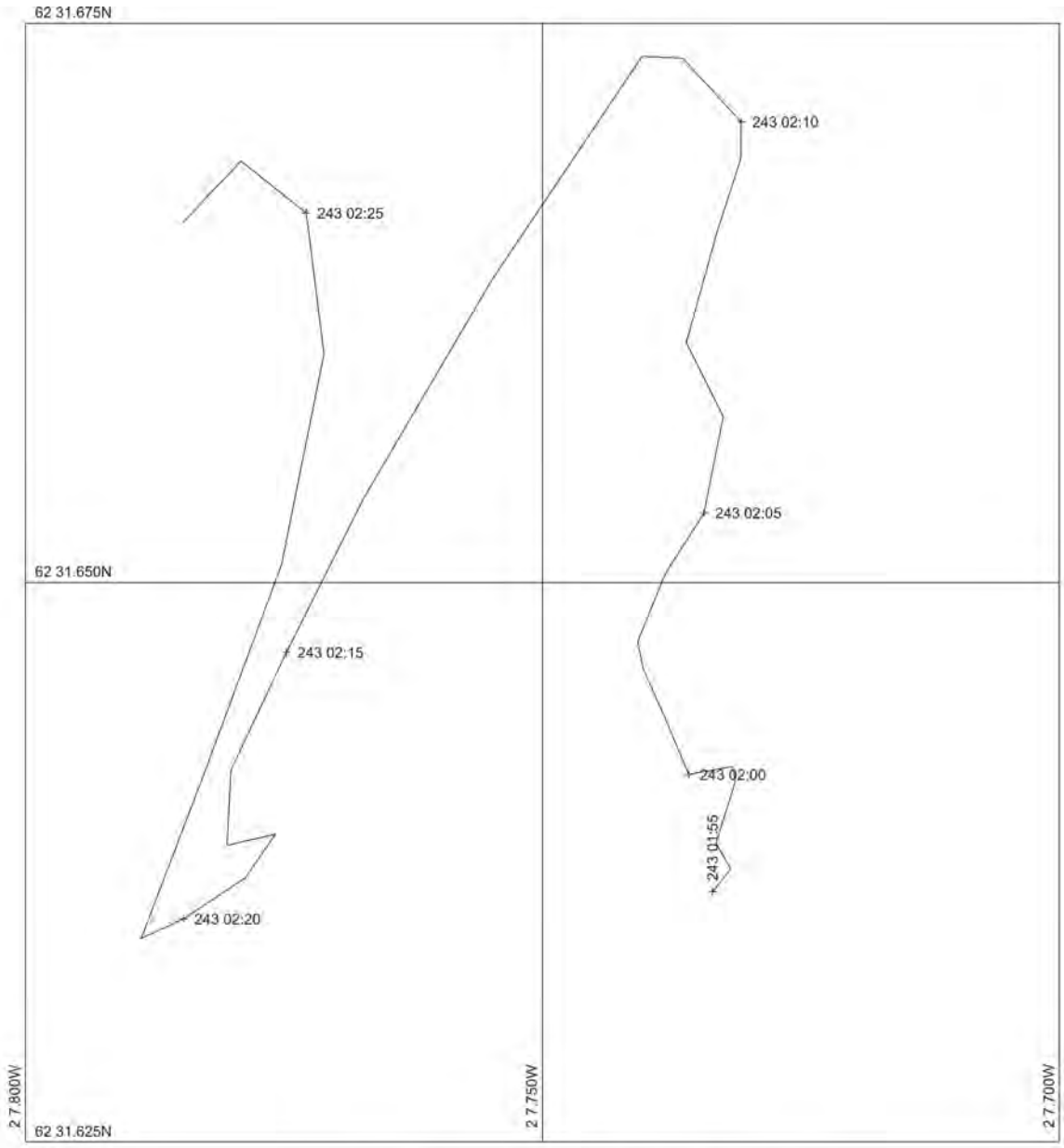

Chart 38. WASP 55046#1, Site FPS1500

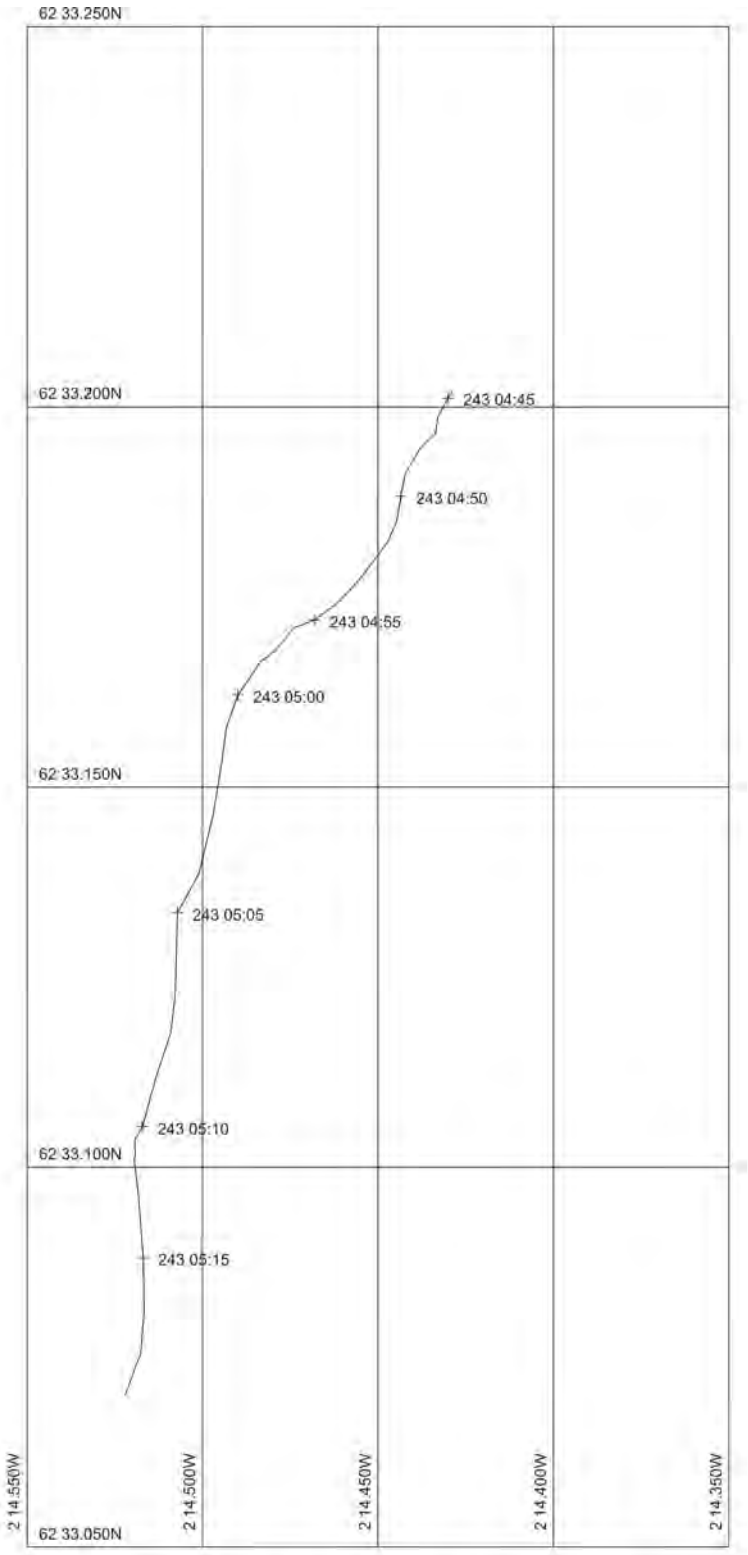

Chart 39. WASP 55047#1, Site FPS1000

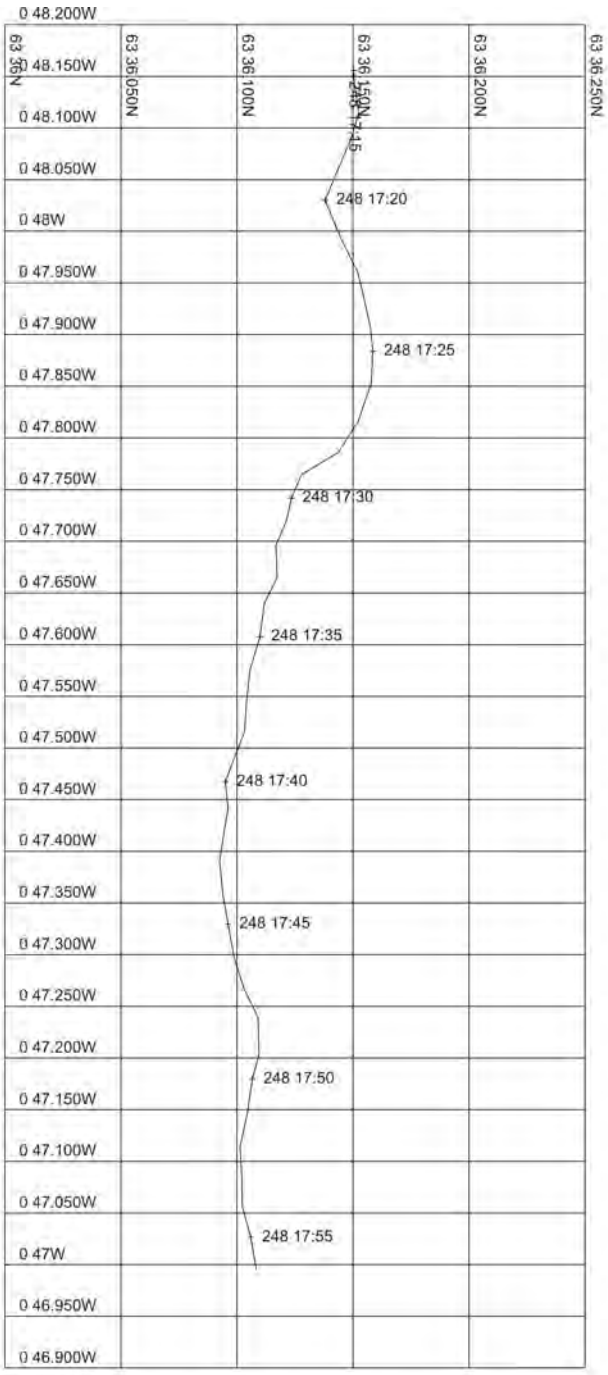

Chart 40. WASP 55049#1, Site NS1

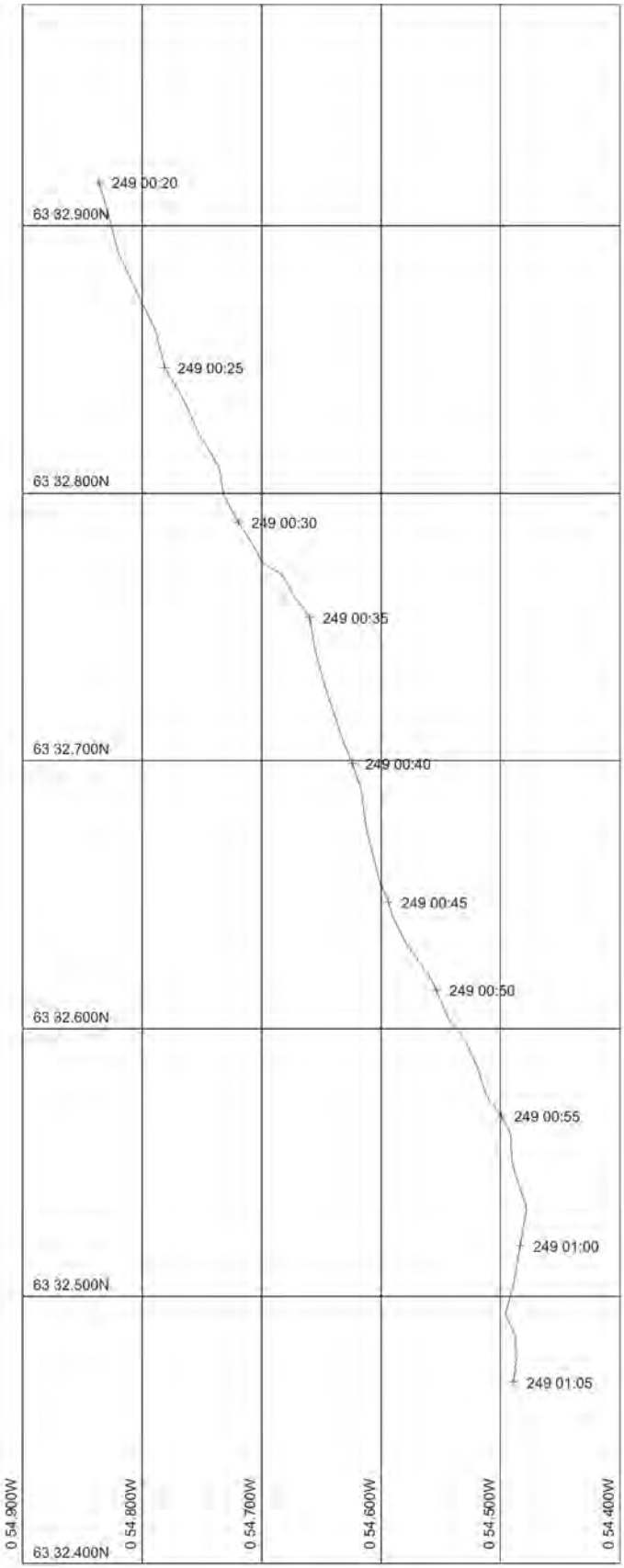

Chart 41. WASP 55050#1, Site NS2

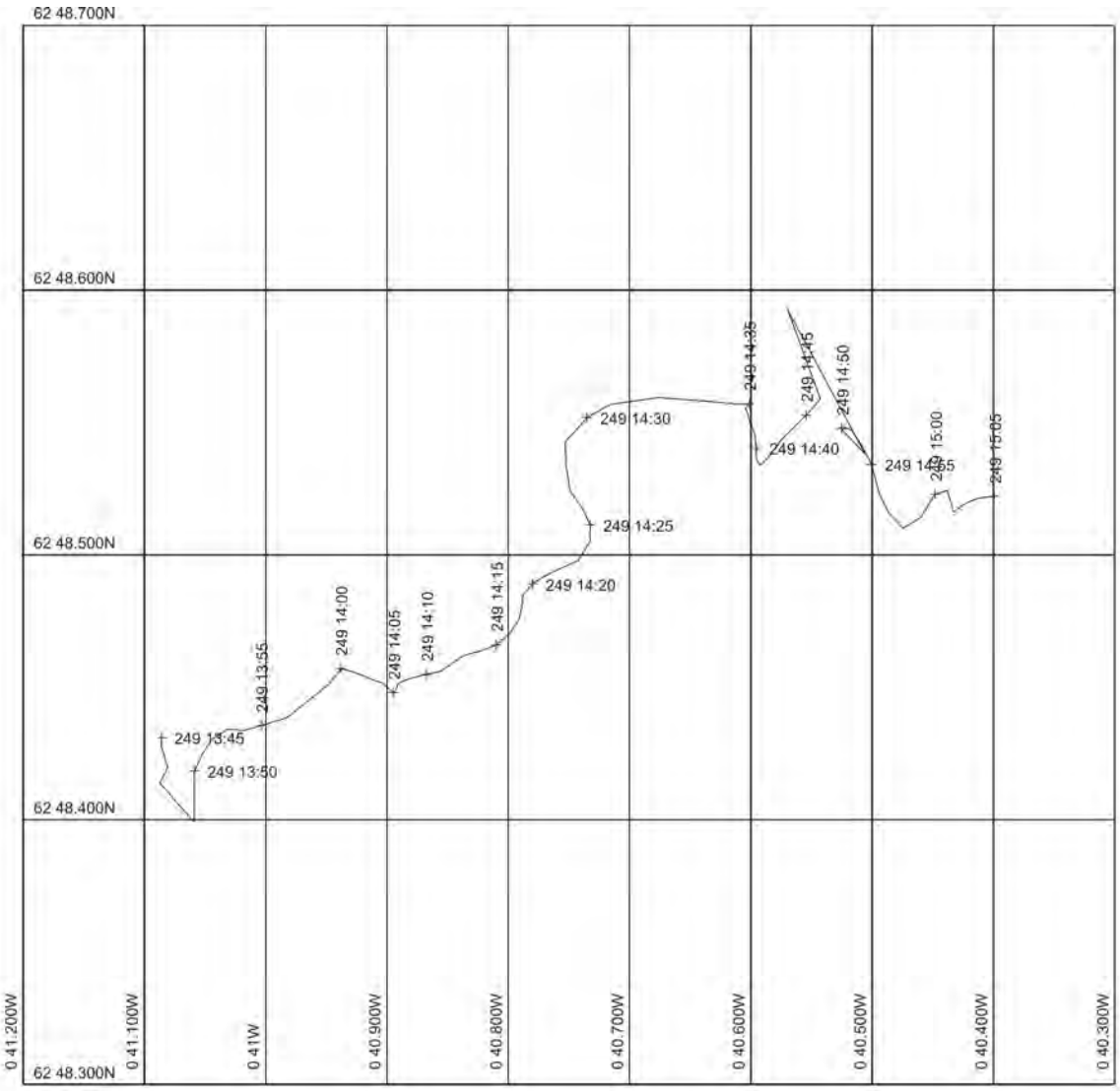

Chart 42. WASP 55051#1, Site NS3

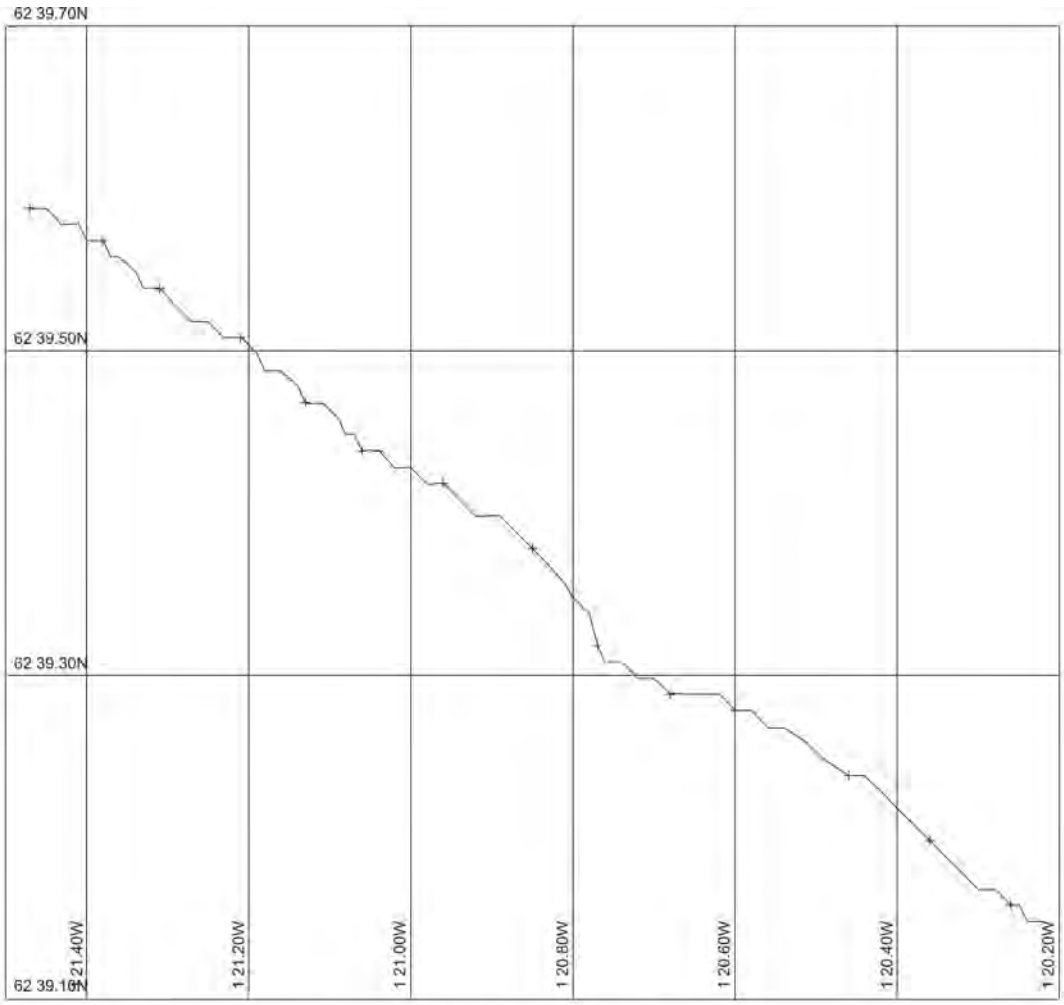

Chart 43. WASP 55052#1, Site NS4

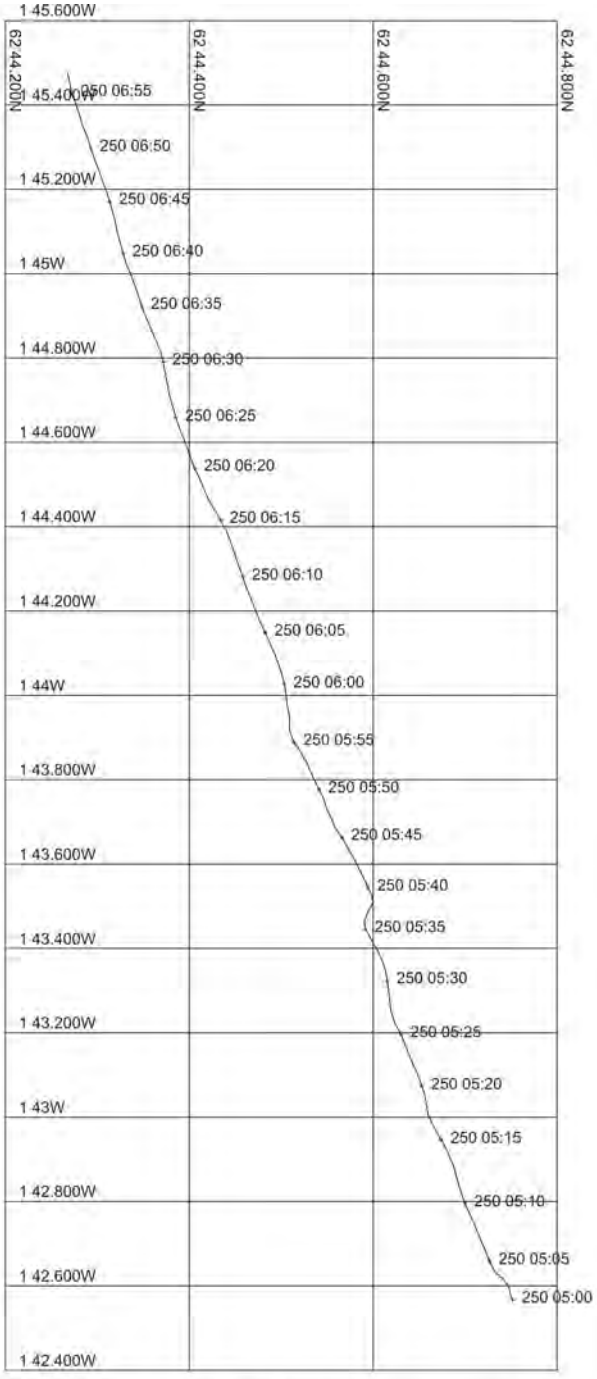

Chart 44. WASP 55053#1, Site FPN1

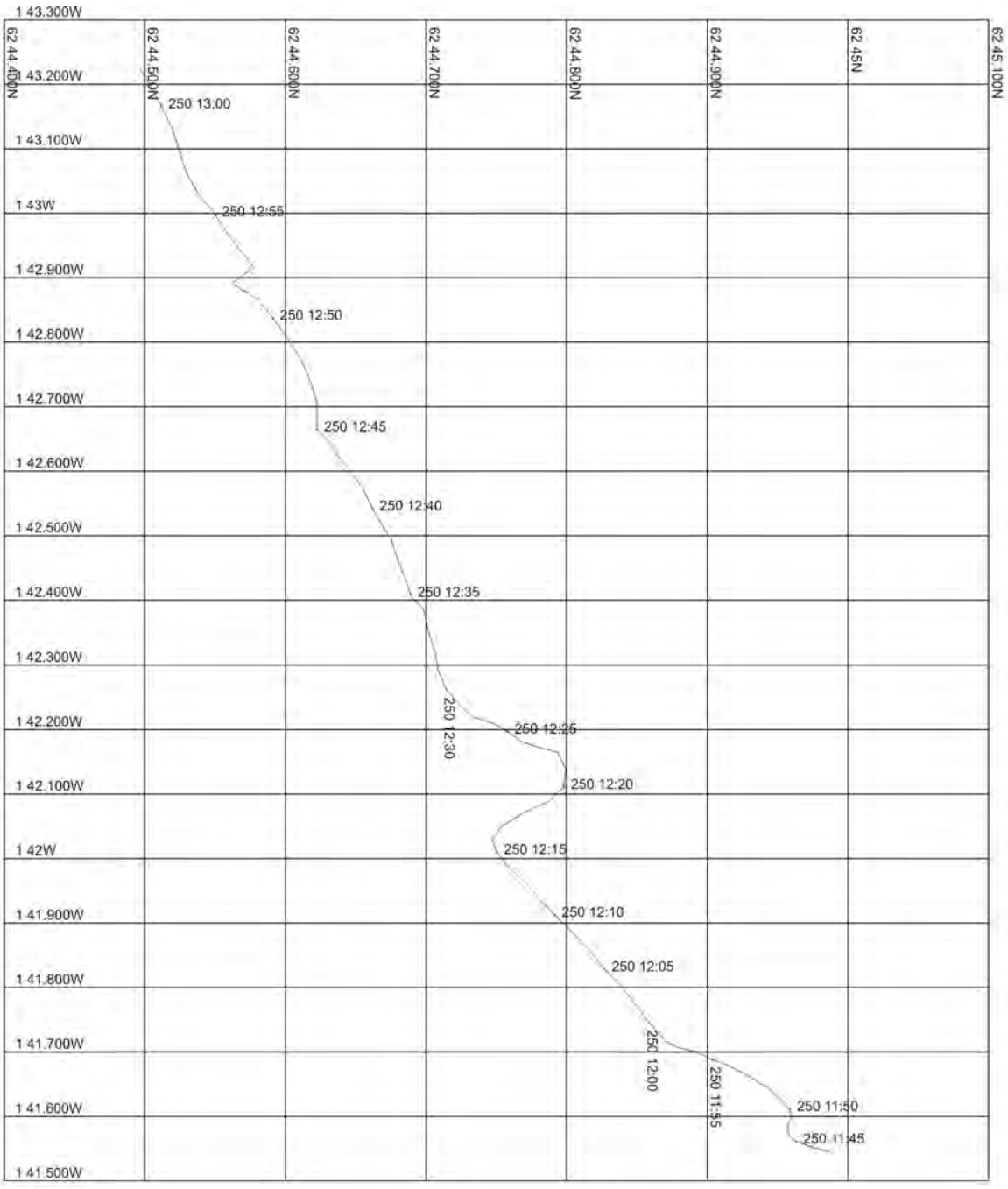

Chart 45. WASP 55055#1, Site FPN1

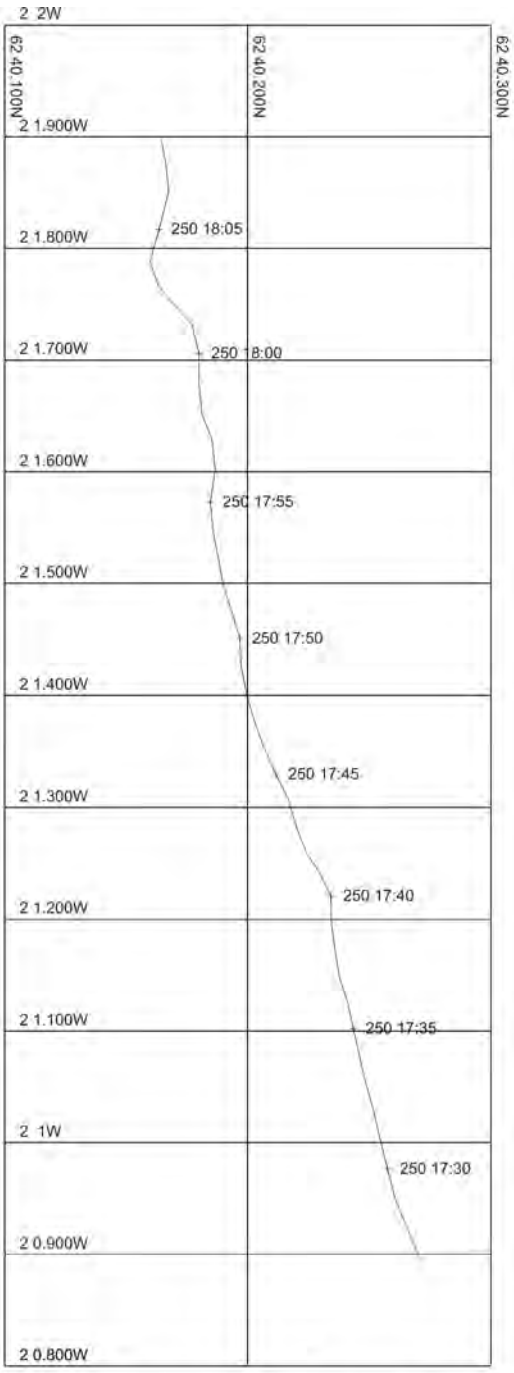

Chart 46. WASP 55056#1, Site FPN1400

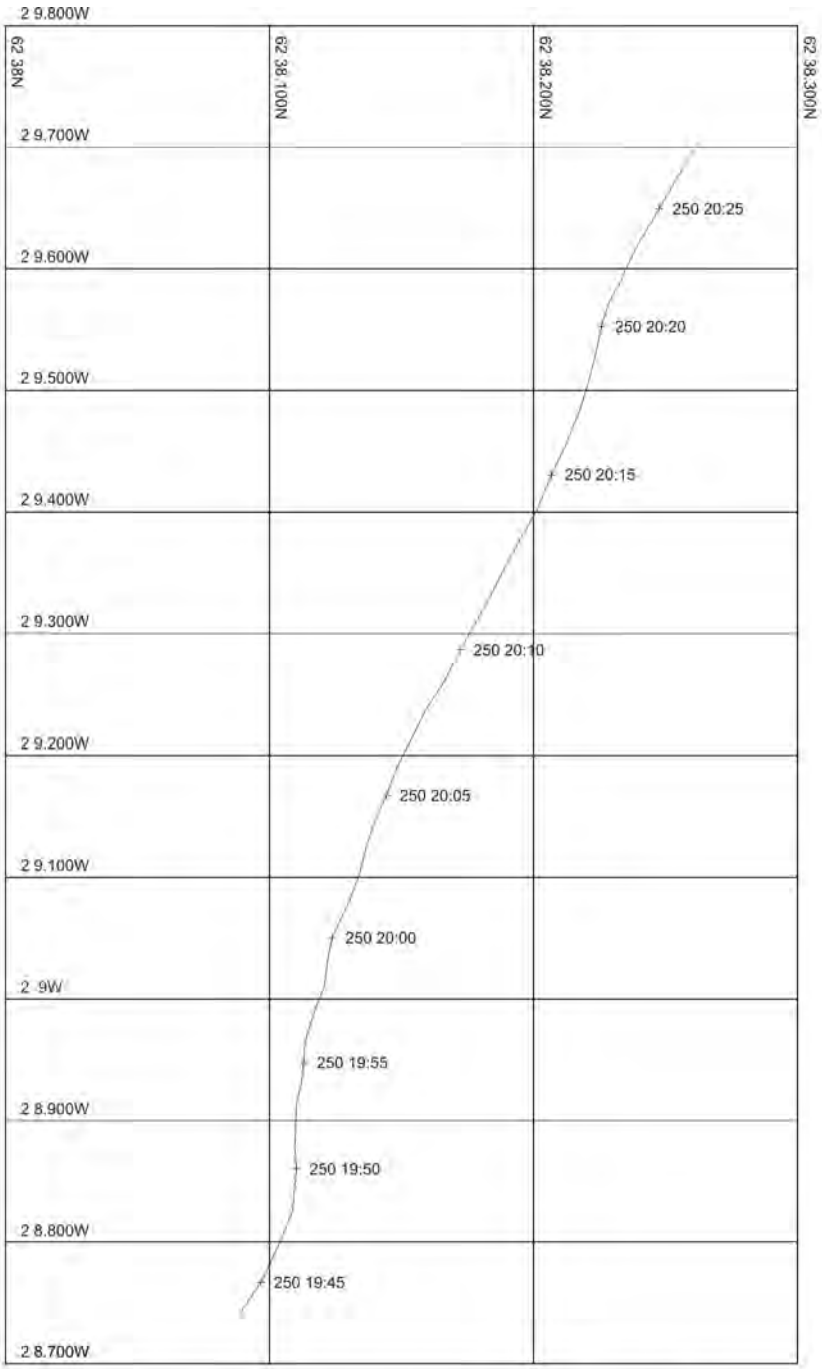

Chart 47. WASP 55057#1, Site FPN1100

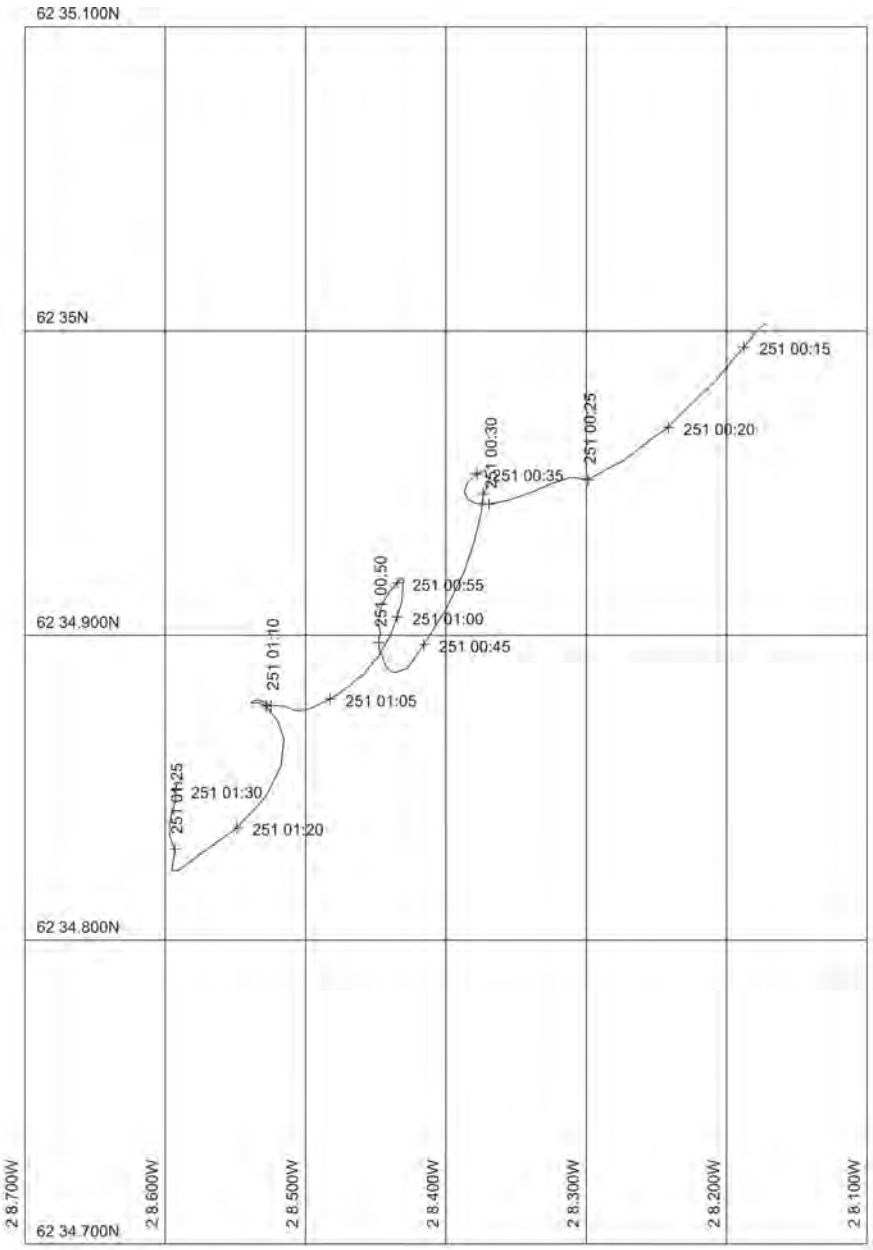

Chart 48. WASP 55058#1, Site FPN2

13. APPENDIX I

Initial assessment of seabed observations made during the White Zone (WhiZ) Environmental Survey (Seabed survey of the deep waters to the north and west of Shetland**,** 13 August-14 September, 1999**)**

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2007

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13.1. Introduction

This report addresses the seabed observations made during the course of the White Zone (WhiZ) Environmental Survey carried out from RRS *Charles Darwin* cruise 119C leg B (13 August-14 September, 1999**)**. What follows is based on visual observations of the seabed made from recovered core samples and WASP video and photographic footage.

The WASP and coring programme undertaken on cruise 119C leg B was designed to ground truth the preceding sidescan sonar survey and to provide an initial assessment of the seabed environment at selected locations within the survey area. The design of the seabed observation programme, as detailed in section 6, was based on both a) the investigation of specific sidescan sonar 'targets', and b) obtaining coverage of other sites selected principally on bathymetric grounds. Water depth is typically the dominant environmental factor in the distribution of the deep-sea fauna (e.g. Gage and Tyler, 1991). This is particularly true in the Faroe Bank and Faroe-Shetland Channels, where extremes of temperature variation occur within a narrow bathymetric range (e.g. Turrell et al., 1999).

Given the likely significance of hydrographic factors, principally temperature, in controlling the distribution of the fauna in the White Zone survey area, this report will also detail water column temperature data recorded by the TOBI sidescan sonar vehicle during cruise 119C leg A. TOBI carries a Falmouth Scientific Instruments Micro-CTD, data from this instrument was processed during cruise 119C leg B and is presented below as an introduction to the environment of the Faroe Bank and Faroe-Shetland Channels.

13.2. Observations

Hydrographic environment

The water column temperature data recorded by the CTD aboard the TOBI sidescan sonar vehicle during cruise 119C leg A was separated in to four geographic regions: a) northern Rockall Trough, b) Faroe Bank Channel (south), c) Faroe Bank Channel (north), and d) Faroe-Shetland Channel (south and west). Figure 6 illustrates the water column temperature ranges encountered in each of these geographic areas. Note that north of the Wyville Thomson Ridge (areas b-d), water column temperature declines rapidly with depth below 500 m in marked contrast to the northern Rockall Trough area where temperature changes little between the surface and the maximum water depth studied (approximately 700 m). North of the Wyville Thomson Ridge, sub-zero water temperatures were encountered in all areas; from around 600 m in the cases of area b) and d) but somewhat deeper in area d).

Seabed environment

Observations of the seabed environment are detailed below in note form. Each entry has the following format:

Site:	Site name used during the survey
Designation:	Location type, i.e. a named TOBI target or general / bathymetric site
Observations:	Information available (by gear type and station number)
Notes:	Observations on the nature of the seabed and its fauna and any other points of note.

Site:	A
Designation:	Tail mounds (as per *Darwin Mounds*)
Observations:	WASP 55002#1, (Megacore 55002#3)
Notes:	Depth c. 1,050 m, a field of small (100 m diameter) tailed mounds (sand volcanoes), apparently identical to the 'Darwin Mounds' previously studied during the AFEN 1998 survey (RRS *Charles Darwin* cruise 112C, see Bett, 1999, 2000). Coral (*Lophelia pertusa*) observed as a few small clumps and a number of isolated colonies. Xenophyophores (*Syringammina fragilissima*) very abundant. Large sponge growths on rocks. Fish (rattails and rabbit fish) and invertebrates (asteroids, cidarids and echinothurids) common. Presence of a number of cobbles and rocks marks the ground as a little different from the western Darwin Mound field, sediment also perhaps a little more silty.

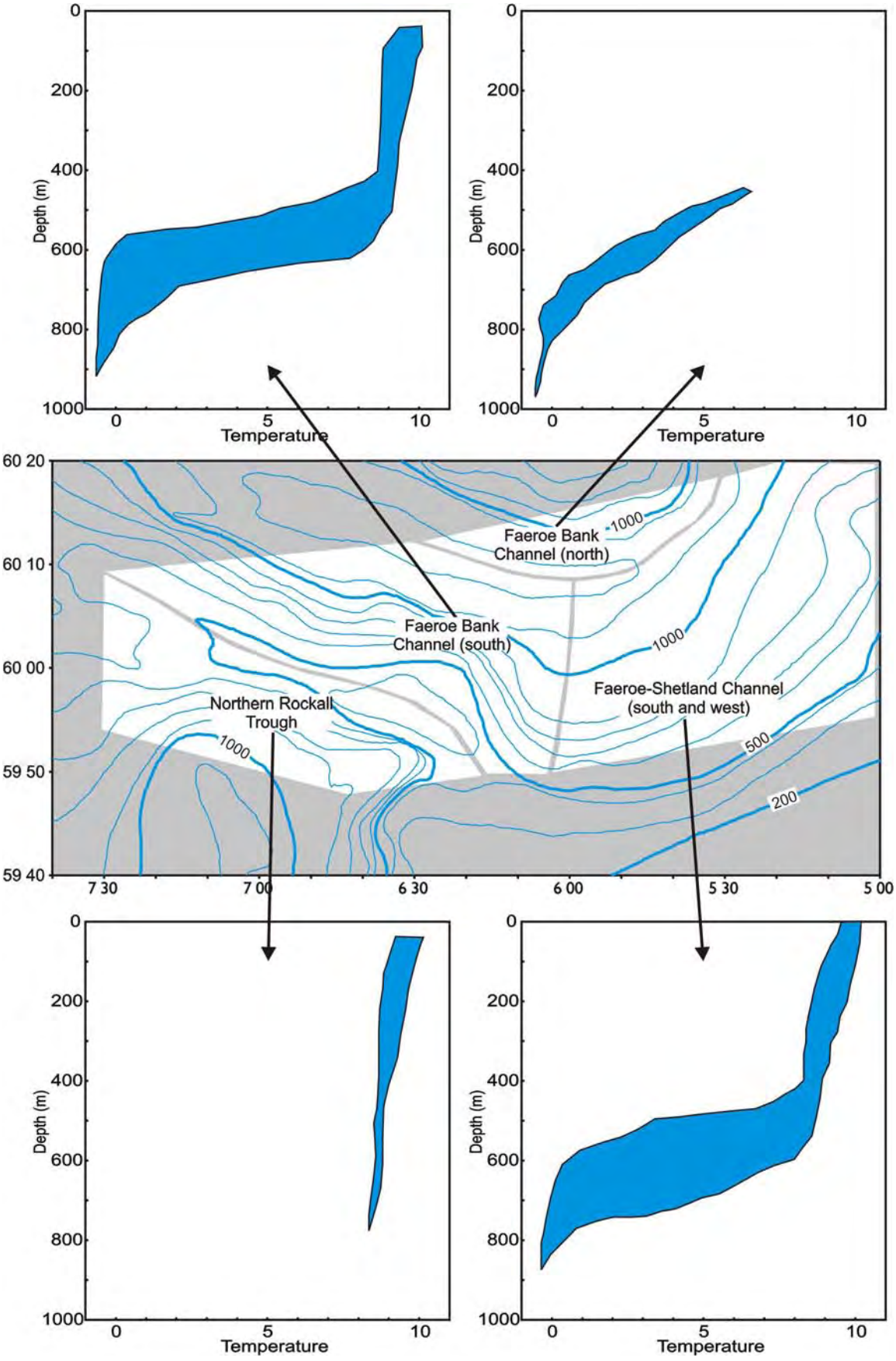

Figure 6. Water column temperature ranges encountered by the TOBI sidescan sonar vehicle during RRS *Charles Darwin* cruise 119C leg A

Site:	B
Designation:	The lump / plug (? rock outcrop)
Observations:	WASP 55003#1
Notes:	Depth c. 550 m, echo-sounding established that the target was a south facing scarp, rather than a lump. Rather rocky ground with variable but near complete cover with various mixtures of gravel, cobbles, rocks and boulders. Variation possibly a reflection of iceberg ploughmarking. Generally a well developed sponge fauna with a good number of mobile invertebrates, particularly cidarids and holothurians also a good number of fish, particularly *Helicolenus*.

Site:	C
Designation:	Fine, downslope lineations
Observations:	Megacorer 55004#1
Notes:	Depth c. 500 m, site cored only. Gravel over sand, no obvious fauna.

Site:	E
Designation:	Large, open iceberg ploughmark
Observations:	WASP 55011#1
Notes:	Depth c. 475 m. Ground varies from dense gravel (and some cobbles) cover to a more rocky ground, possible expression of iceberg ploughmarks. Gravel areas are often well tracked (ploughed) by spatangoids. Rockier areas have a modest encrusting epifauna, with branched sponges being common. Epifauna seen to be moving in appreciable bottom current. Cidarids, holothurians and geryonid crabs are frequent, fish (*Helicolenus* and ling) also common. A cable or cables (? long-line) seen numerous times during the run, also a piece of netting.

Site:	G1
Designation:	? Overflow channel
Observations:	WASP 55025#1
Notes:	Depth c. 550 m. Ground generally varies from dense gravel to very rocky, though includes areas of relatively open sediment and what appear to be rock / boulder piles (or ridges); possible expression of iceberg ploughmarks. Gravel areas with little obvious fauna, some echinoids and fish (torsk and halibut). On rockier ground brittlestars may be very abundant (forming a carpet), massive sponges may also be common.

Site:	G2
Designation:	? Overflow channel
Observations:	WASP 55026#1
Notes:	Depth c. 480 m. A gravely pavement with variable cobble cover, occasional boulders; ? expression of iceberg ploughmarks. Brittlestars may be extremely numerous (forming a carpet). Some asteroids and echinoids present. Wire / rope strands observed.

Site:	J
Designation:	"Very black hole" (contourite as per AFEN '96 survey)
Observations:	WASP 55023#1, Megacorer 55023#2
Notes:	Depth c. 1,000 m. Sandy seabed with no ripples and no indication of gravel or rocks. Seabed apparently uniform throughout tow, however, dominant fauna may vary. Initially dominated by both abundant stalked sponges and abundant 'tubes' (? sabellids), the former of markedly reduced abundance by end of run. Both the sponges and tubes indicate a flowing bottom current. Other notable fauna includes pycnogonids (also recovered on core tops) a large pennatulid / solitary hydroid, and fish (lycodids and rockling). Cluster burrows ('fairy rings' = ? enteropneusts) quite common. Note that this area has clear affinities with other locations (see below) dominated by stalked sponges, but is clearly differentiated from them by the presence of, and subsequent dominance by, ? sabellids.

Site:	K
Designation:	Upper ridge mottled area
Observations:	WASP 55024#1
Notes:	Depth c 520 m. Ground varies from gravel / cobble pavement to very rocky; possible expression of iceberg ploughmarks. Gravel areas with very little obvious fauna. Rockier ground with sponges (massive and fan forms), octocorals, asteroids, and echinoids. Some areas of dense featherstar cover (carpet forming).

Site:	L
Designation:	Faroe Bank Channel mottled area
Observations:	WASP 55022#1, Megacorer 55022#2
Notes:	Depth c. 1,050 m. Sandy bottom with no obvious rippling. Gravel or rocks not generally present, however, one discrete patch of rocks observed - ? may equate to a 'mottle'. High density population of stalked sponges. Cluster burrows ('fairy rings' = ? enteropneusts) also numerous. Other fauna includes pycnogonids (also recovered from core tops), pennatulids / solitary hydroids, anemones, octocorals and fish (lycodids, rockling and ray).

Site:	N1
Designation:	Boundary contourite / lineations (lineation side)
Observations:	WASP 55015#1, box corer 55015#2
Notes:	Depth c. 1,150 m. Ground varies from dense gravel cover to rock / cobble / gravel pavement, some boulders (some with comet marks) - ? variation responsible for the sidescan lineations. Rock / cobble areas with numerous featherstars; two species of sponges (tubular and branched tubular) also common. Fish (lycodids) frequently observed, pycnogonids and cerianthids recovered from core sample.

Site:	N2
Designation:	Boundary contourite / lineations (contourite side)
Observations:	WASP 55014#2, Megacorer 55014#1
Notes:	Depth c. 1,200 m. Rather featureless seafloor of sand with fine gravel cover, no rocks / cobbles observed. Lebenspurren (tracks) present but little obvious fauna. Pennatulids, asteroids and fish (lycodids) observed, ophiuroids recovered from core tops.

Site:	P
Designation:	Larger furrows / lineations
Observations:	WASP 55016#1
Notes:	Depth c. 1,200 m. Generally, a dense cover of fine gravel with cobbles, some rocks and the occasional boulder (some comet marks). ? Some open sediment patches / streaks - if ‘lineations’ were crossed during this run then they were not particularly marked at the seabed; conceivable that they may reflect areas of greater and lesser gravel / cobble cover. Sponges (massive, tubular and ‘bottle-brush), octocorals and fish (lycodids) the most evident fauna. Generally similar to site N1.

Site:	Q
Designation:	Smaller furrows / lineations
Observations:	WASP 55032#1
Notes:	Depth c. 1,070 m. Seabed with very dense gravel cover and variable cobble / rock cover - ? responsible for sidescan lineations. Substantial bottom current flowing. Relatively abundant fauna of branched tubular sponges, featherstars and octocorals. Large anemones, pycnogonids, and fish (rockling / lycodids).

Site:	R1
Designation:	Barchan dunes (and lineations)
Observations:	WASP 55030#1
Notes:	Depth c. 1,125 m. Generally a gravely sand seabed, with gravel streaks, some cobbles, some rocks with scour. No obvious indication of the presence of sand barchans. Generally little obvious fauna, though it improves on the cobbles / rocks. Possible 'biological turf' (small tube worms and ophiuroids) in the open gravely sand areas. Fauna observed includes: anemones, octocorals, pennatulids / solitary hydroids, octopus, and fish (lycodids and rockling). No burrows observed.

Site:	R2
Designation:	Barchan dunes (and lineations)
Observations:	WASP 55031#1
Notes:	Depth c. 1,135 m. Gravely sand seabed, with gravel streaks and some rocks (some with associated sand streak behind). Little obvious fauna. Anemones, pennatulids / solitary hydroids and asteroids noted. No burrows observed. Generally very similar to site R1.

Site:	S
Designation:	Debris flow channels
Observations:	WASP 55033#1
Notes:	Depth c. 950 m. Sandy sediment with little if any gravel and no rocks / cobbles. Sand is somewhat modelled / rippled. Number of small tracks akin to those of the surface dwelling enteropneust of the 'Black Hole' contourite observed West of Shetland during the AFEN 1996 survey (see Bett, 1997, 2000). Fauna somewhat sparse (pycnogonids, gastropods, fish - lycodids, rockling and other).

Site:	T
Designation:	Ridge crest, iceberg ploughmark zone
Observations:	Box corer 55009#2
Notes:	Depth c. 525 m. Site cored only. Core surface covered by a gravel / cobble pavement. Encrusting fauna included sponges, anemones, bryozoans and brachiopods.

Site:	V
Designation:	Ridge crest, iceberg ploughmark zone
Observations:	WASP 55027#1
Notes:	Depth c. 360 m. Seabed of generally very gravely sand with patches of rock / cobbles; possible expression of iceberg ploughmarks. Fauna generally dominated by holothurians and cidarids, with asteroids and galatheids also notable. Encrusting fauna generally poorly developed (sponges principally).

	Possible trawl mark observed.
Site:	W
Designation:	Possible overflow route / lineations
Observations:	WASP as 55010#1, box corer 55010#2
Notes:	Depth c. 500 m. Gravely sand bottom with variable quantities of cobbles, rocks and boulders; possible expression of iceberg ploughmarking. A close encrusting fauna (mainly sponges) present, but frequently not particularly well developed. Cidarids and holothurians dominant amongst the mobile invertebrates. Ploughing spatangoids observed in the open ground areas. Rabbit fish numerous.

Site:	FBC500
Designation:	Bathymetric transect
Observations:	WASP 55012#4 (Megacorer 55008#1, box corers 55012#1, #2)
Notes:	Depth c. 500 m. Generally a gravely sand seabed with variable cobble / rock / boulder cover; possible expression of iceberg ploughmarking. Sponges (massive, fan / cup and close encrusting blue forms) visually dominant in the rockier areas. Gastropods, stone crabs, cidarids, brachiopods, and fish (ling) also noted. Rope / cable observed.

Site:	FBC800
Designation:	Bathymetric transect
Observations:	WASP 55007#1, (Megacores 55007#2 and #3)
Notes:	Depth c. 850 m. Gravely sand seabed with variable rocks and boulders. Rockier ground visually dominated by large tubular sponges, other sponges also present (fan and 'bottle-brush' forms). Other fauna noted includes asteroids, pycnogonids, octocorals and fish (rockling and lycodids).

Site:	FBC1000
Designation:	Bathymetric transect
Observations:	WASP station 55006#1, Megacore 55006#3, (Megacore 55006#2)
Notes:	Depth c. 1,000 m. Gravely (muddy) sand seabed with variable rocks and boulders. Numerous 'tubes' (? sabellids). Some stalked sponges present. Rocks with large tubular sponges and octocorals. Cluster burrows ('fairy rings' = enteropneusts) quite frequent. Other fauna observed includes cerianthids, ophiuroids, pycnogonids, pennatulids / solitary hydroids, and fish (rays).

Site:	FBC1200
Designation:	Bathymetric transect
Observations:	WASP 55005#2, Megacorer 55005#1
Notes:	Depth c. 1,180 m. Sandy ground (not rippled) with one single patch of rocks / boulders observed. Fauna dominated by very numerous stalked sponges.

Some large, single entrance burrows. Pycnogonids, asteroids and fish (lycodids) also observed.

Site: FSC300
Designation: Bathymetric transect
Observations: WASP 55017#1
Notes: Depth c. 260 m. Gravely sand with variable cobble / rock cover; possible expression of iceberg ploughmarking. Generally little obvious fauna, encrusting epifauna very poorly developed (similar to southern area of AFEN 1996 survey; see Bett, 1997, 2000). Some holothurians, hermit crabs, asteroids, cerianthids and fish (*Helicolenus*, rattail, ling) noted. Numerous trawl marks observed.

Site: FSC500
Designation: Bathymetric transect
Observations: WASP 55018#2, box corer 55018#1
Notes: Depth c. 500 m. Gravely sand seabed (some rippling) with some rocks (iceberg ploughmarking not apparent). Generally little obvious fauna, encrusting epifauna very poorly developed (similar to southern area of AFEN 1996 survey; see Bett, 1997, 2000). Fauna noted includes close encrusting blue sponge, spider crab, and fish (?*Sebastes*, flatfish).

Site: FSC800
Designation: Bathymetric transect
Observations: WASP 55019#1
Notes: Depth c. 760 m. Seabed of (muddy) sand with little gravel and some rocks (some rock 'aggregations'). Rocks appear to have partial sediment cover and are often colonised by tubular sponges. An appreciable but not particularly well developed encrusting epifauna. Cluster burrows ('fairy rings' = enteropneusts) common. Other fauna observed includes pycnogonids, asteroids, octocorals and fish (lycodids, rockling, rays).

Site: FSC1000
Designation: Bathymetric transect
Observations: WASP as 55020#1, Megacorer 55029#1
Notes: Depth c. 970 m. Sandy sediment, not rippled, with little or no gravel nor rocks. Stalked sponges numerous. Other fauna includes ? sabellids, pennatulids / solitary hydroids, pycnogonids, cerianthids and fish (rockling, lycodids, rays).

Site: FSC1200
Designation: Bathymetric transect
Observations: WASPs 55021#1 and 55028#1
Notes: Depth c. 1,130 m. Intriguing, strongly rippled sandy seabed. Possibly mobile sand over a more consolidated base. Rippling varies repeatedly - parallel ripples, curving ripples, an 'edge', 'chaotic' ripples (possibly on slightly elevated topography), infilled ripples, return to parallel ripples - ? barchan

dune field. Little obvious fauna, small anemones, pennatulids /solitary hydroids, pycnogonids and gastropods.

Site: X1
Designation: General coverage central Faroe-Shetland Channel
Observations: WASP 55035#1, Megacorer 55037#2, (Megacorer 55037#1)
Notes: Depth c. 900 m. Gravely sand with cobbles and rocks and occasional boulders (some with scour). Fauna dominated by octocorals, featherstars and pycnogonids. Other fauna observed includes 'bottle-brush' sponge, asteroids and fish (lycodids).

Site: X2
Designation: General coverage central Faroe-Shetland Channel
Observations: WASP 55038#1, Megacorer 55041#1
Notes: Depth c. 1,050 m. Sandy gravel with rocks. Appreciable bottom water flow apparent. Generally very similar to site X1. Fauna noted includes octocorals, pycnogonids, asteroids, sabellids, cerianthids, stalked sponges and fish (rockling). (Cirrate octopus observed above seabed on four occasions during the run).

Site: X3
Designation: General coverage central Faroe-Shetland Channel
Observations: WASP 55039#1, Megacorer 55042#1
Notes: Depth c. 1,120 m. Gravely sand with cobbles and rocks (some with scour). Fauna dominated by ophiuroids and cerianthids. Other fauna noted includes asteroids, pycnogonids, octocorals and fish (lycodids and rockling). (Cirrate octopus observed above seabed). Cable observed. Note that although the seabed is of very similar appearance to that of sites X1 and X2 the fauna appears to be somewhat distinct.

Site: Y1
Designation: General coverage central Faroe-Shetland Channel
Observations: WASP 55043#1
Notes: Depth c. 1,020 m. Gravely sand with rocks and boulders (some with scour). Appreciable bottom current flowing. Similar seabed and fauna to sites X1 and X2. With featherstars and tubular sponge frequent. Other fauna noted includes octocorals, asteroids, gastropods, pennatulids / solitary hydroids, and fish (lycodids and rockling).

Site: FPS1000
Designation: Bathymetric transect
Observations: WASP station 55047#1
Notes: Depth c. 980 m. Gravely (muddy) sand with abundant cobbles, some boulders with scour. Brisingiids and ophiuroids most common. Other fauna

including octocorals, tubular sponges, other asteroids, pycnogonids and fish (lycodids and rockling).

Site: FPS1500
Designation: Bathymetric transect
Observations: WASP 55046#1
Notes: Depth c. 1,440 m. Gravely (muddy) sand with cobbles, rocks and occasional boulders (some with scour). Fauna dominated by pennatulids / solitary hydroids and octocorals. Other fauna noted includes branched sponges, asteroids, ophiuroids, large ascidians and fish (rockling).

Site: FPS1800
Designation: Bathymetric transect
Observations: WASP 55045#1
Notes: Depth c. 1,725 m. A rather uniform featureless (sandy) mud seabed, with no rocks and little if any gravel. Very little obvious fauna, though very numerous conical pit burrows. Fauna dominated by ophiuroids and lesser number of stalked ascidians. Other fauna noted includes asteroids, pennatulids, and fish (lycodids).

Site: FPN1100
Designation: Bathymetric transect
Observations: WASP 55057#1, Megacorer 55057#2
Notes: Depth c. 1,080 m. Muddy sand / sandy mud ground with gravel and rocks (some boulders with scour). Large ophiuroids, asteroids and sabellids dominate the open sediment areas. A relatively well developed epifauna of tubular sponges, octocorals and ascidians in the rockier areas. Other fauna includes featherstars, anemones, pycnogonids, pennatulids, tubular sponges, cerianthids, and fish (rockling and lycodids).

Site: FPN1400
Designation: Bathymetric transect
Observations: WASP 55056#2, Megacorer 55056#1
Notes: Depth c. 1,350 m. Muddy sand / sandy mud ground with rocks (some boulders with scour). Ophiuroids and sabellids (both observed on core tops) dominate the open ground, with octocorals and branching fan sponges frequent in the rockier areas. Other fauna noted includes asteroids, pennatulids, anemones, ascidians, pycnogonids and fish (rays and rockling).

Site: FPN1800
Designation: Bathymetric transect
Observations: Megacorer 55054#1
Notes: Depth c. 1,700 m. Site cored only. Muddy sediment, no gravel observed.

Site:	FPN1
Designation:	Complex TOBI feature (line 16)
Observations:	WASPs 55053#1, 55055#1
Notes:	Depth c. 1,740 m. For 55053#1 and the majority of 55055#1, a featureless creamy mud seafloor. Numerous simple (possibly paired) burrow openings. Fauna dominated by asteroids (at least their lebenspurren - tracks and feeding traces) and ophiuroids. Other fauna includes sabellids, octocorals, pennatulids / solitary hydroids, pycnogonids, and fish (indeterminate). End of run 55055#1 encounters the TOBI feature: localised elevated topography with associated rock / boulder scree and a single isolated 'clay block'. No obvious faunal association with the feature.

Site:	FPN2
Designation:	Varied backscatter area
Observations:	WASP 55058#1
Notes:	Depth c. 1,060 m. Gravely (muddy) sand with cobbles and rocks (occasional boulders with scour). Appreciable bottom current flowing. Fauna dominated by brisingiids. Other fauna observed includes ophiuroids, asteroids, tubular sponges, pycnogonids, echinoids, and fish (lycodids and rays).

Site:	NS1
Designation:	General coverage (deep site)
Observations:	WASP 55049#1, Megacore 55049#2
Notes:	Depth c. 2,275 m. Featureless, uniform creamy mud seafloor. Fauna dominated by a relative dense population of sabellids. Other fauna observed includes octocorals, anemones, ?holothurians, and fish (lycodids and indeterminate). (Numerous medusae observed above the seabed throughout the run).

Site:	NS2
Designation:	Complex TOBI feature (line 25)
Observations:	WASP 55050#1, Megacorer 55050#3
Notes:	Depth c. 2,150 m. Seafloor generally very similar to site NS1, a uniform creamy mud. Similar fauna, though notable for numerous asteroid lebenspurren (tracks and feeding traces). A number of encounters with TOBI features - local elevated topography of fractured, sculptured 'clay blocks' having associated gullies and scree slopes with rocks and boulders. No obvious faunal associations with these features (other than through the availability of hard substrates in the form of rocks and boulders in the otherwise muddy setting).

Site:	NS3
Designation:	General coverage (1,500 m)
Observations:	WASP 55051#1, 55051#2
Notes:	Depth c. 1,470 m. Featureless, uniform seafloor of creamy mud. Fauna overwhelmingly dominated by very numerous small ophiuroids. Large open burrows (possibly paired) also common (?possibly inhabited by fish?). Other fauna rather infrequent, principally asteroids (at least their tracks and feeding traces) and sabellids.

Site:	NS4
Designation:	Complex TOBI feature (line 19)
Observations:	WASP 55052#1, box corer 55052#2
Notes:	Depth c. 1,600 m. Background environment generally very similar to NS3, though without such high density of ophiuroids. A creamy mud marked by large open burrow and asteroid lebenspurren. TOBI features (three) encountered as minor scarps, generally having a ‘scree’ slope (with rocks and boulders) with fractured ‘clay’ blocks above. As with site NS2, there appears to be no obvious faunal associations with these features (other than through the availability of hard substrates in the form of rocks and boulders in the otherwise muddy setting, i.e. colonisation by octocorals and tubular sponges).

13.3. Discussion

The unique hydrographic conditions of the Faroe Bank and Faroe-Shetland Channels undoubtedly play a major role in controlling the distribution of the fauna in this region (see Bett, 2000). The depth distributions of temperature ranges determined in the present survey are very similar to those obtained during the AFEN 1996 survey west of Shetland.

The Darwin Mounds

Being located in the northern Rockall trough, only survey site A, the eastern *Darwin Mounds* field, lies out with these unusual hydrographic conditions. Sidescan sonar images (see figure 7) of this area suggest that it is essentially identical to the western *Darwin Mounds* field discovered during the AFEN 1998 survey (Bett, 2000). It is likely that the previously observed biological zonation around the mounds, i.e. dense xenophyophore populations on the mound tails and coral growths on the mounds themselves, is consistent between the eastern and western fields. The environment of the eastern field appears to be somewhat different in respect of the more abundant occurrence of rocks at the seabed. This may be significant in terms of the relationship between the corals and the mounds. That coral was not obviously seen to be growing attached to these rocks might suggest that the mounds offer some attractive feature beyond an attachment point.

The Faroe Bank Channel area

This area (see figure 8) is particularly heterogeneous with respect to seabed morphology and substrate type. The simplified sidescan sonar interpretation shown on figure 8 identifies four major facies: a) an iceberg ploughmark zone on the Wyville Thomson Ridge and eastern flank of the Faroe-Shetland Channel; b) a sand contourite on the northern flank of the Wyville Thomson Ridge; c) an area of gravel cover on the Faroe slope; and d) a complex area of sand related features at the southern end of the Faroe-Shetland Channel. The unclassified area comprises the lower slopes of the eastern side of the Faroe-Shetland Channel and the southern side of the Faroe Bank Channel. To a greater or lesser extent these various areas / facies can also distinguished in terms of the appearance of the seafloor and its associated fauna.

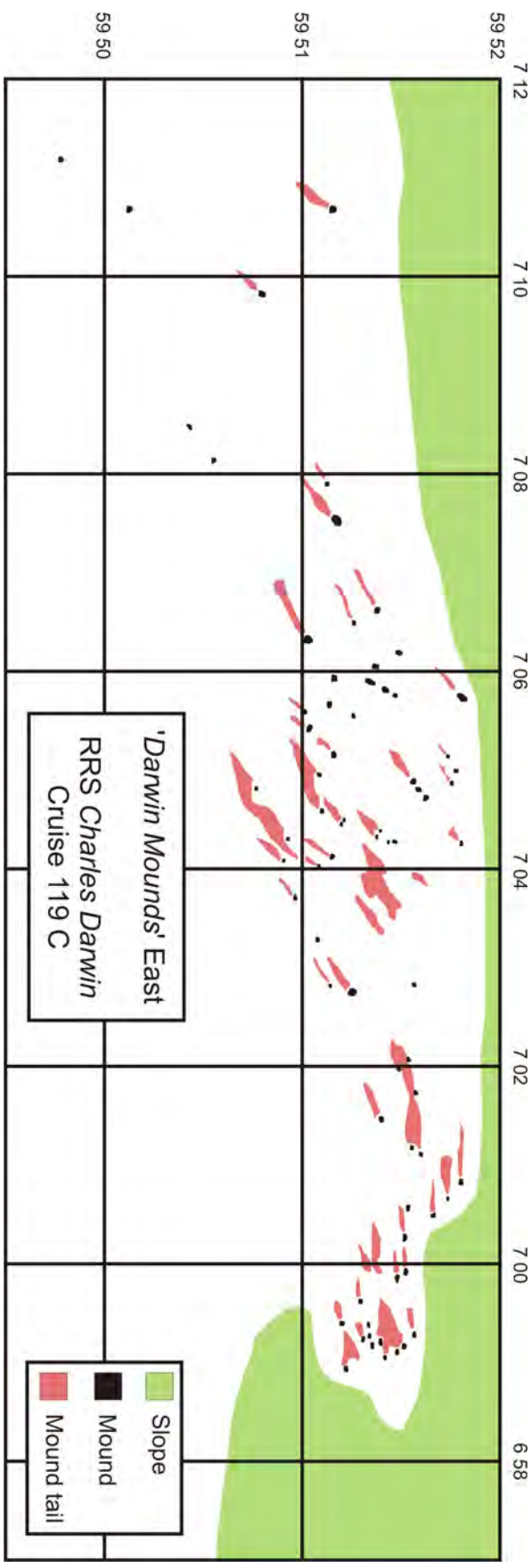

Figure 7. Interpreted sidescan sonar image of the eastern *Darwin Mounds* field.

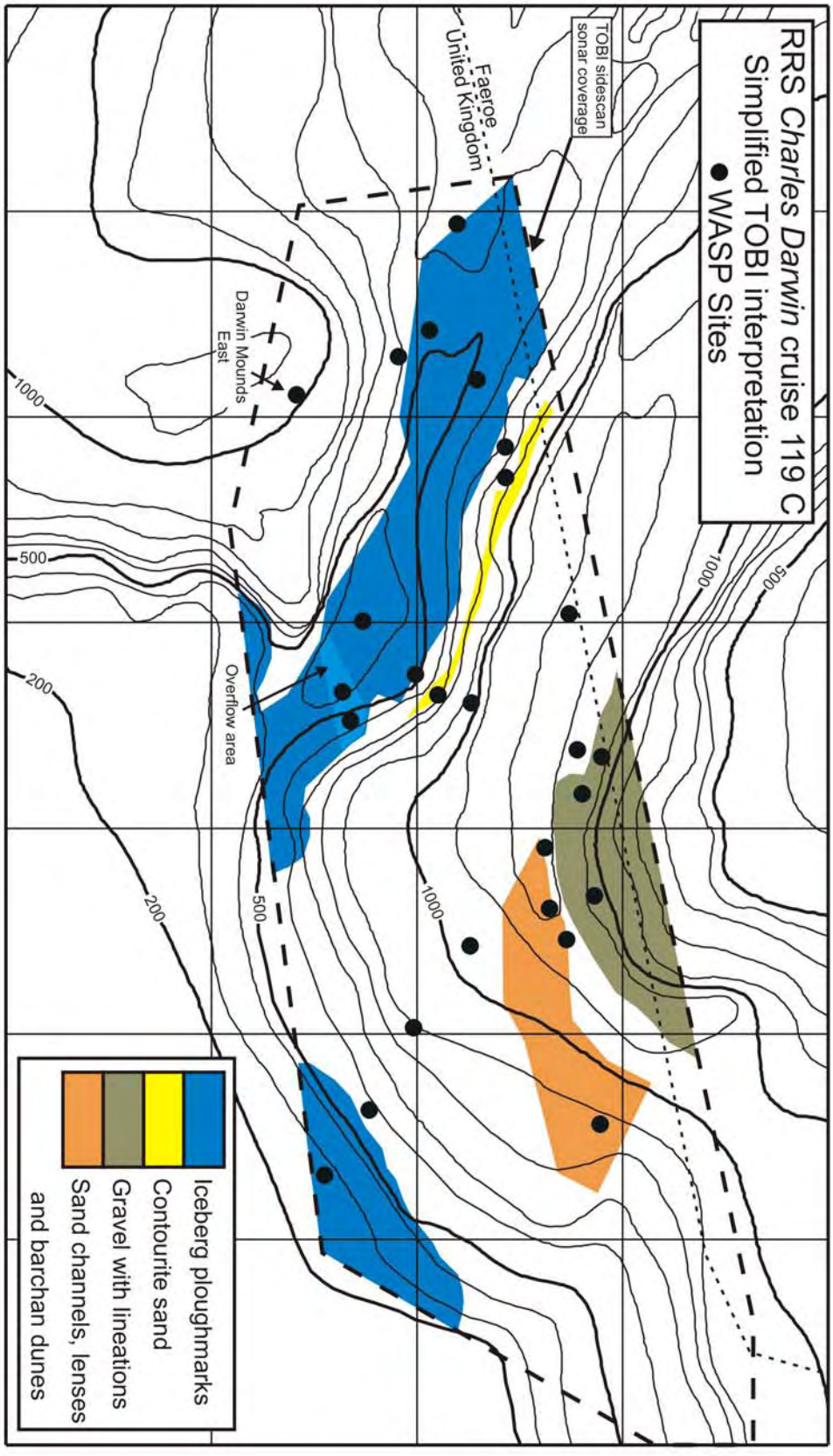

Figure 8. Simplified sidescan sonar interpretation of the Faroe Bank Channel area.

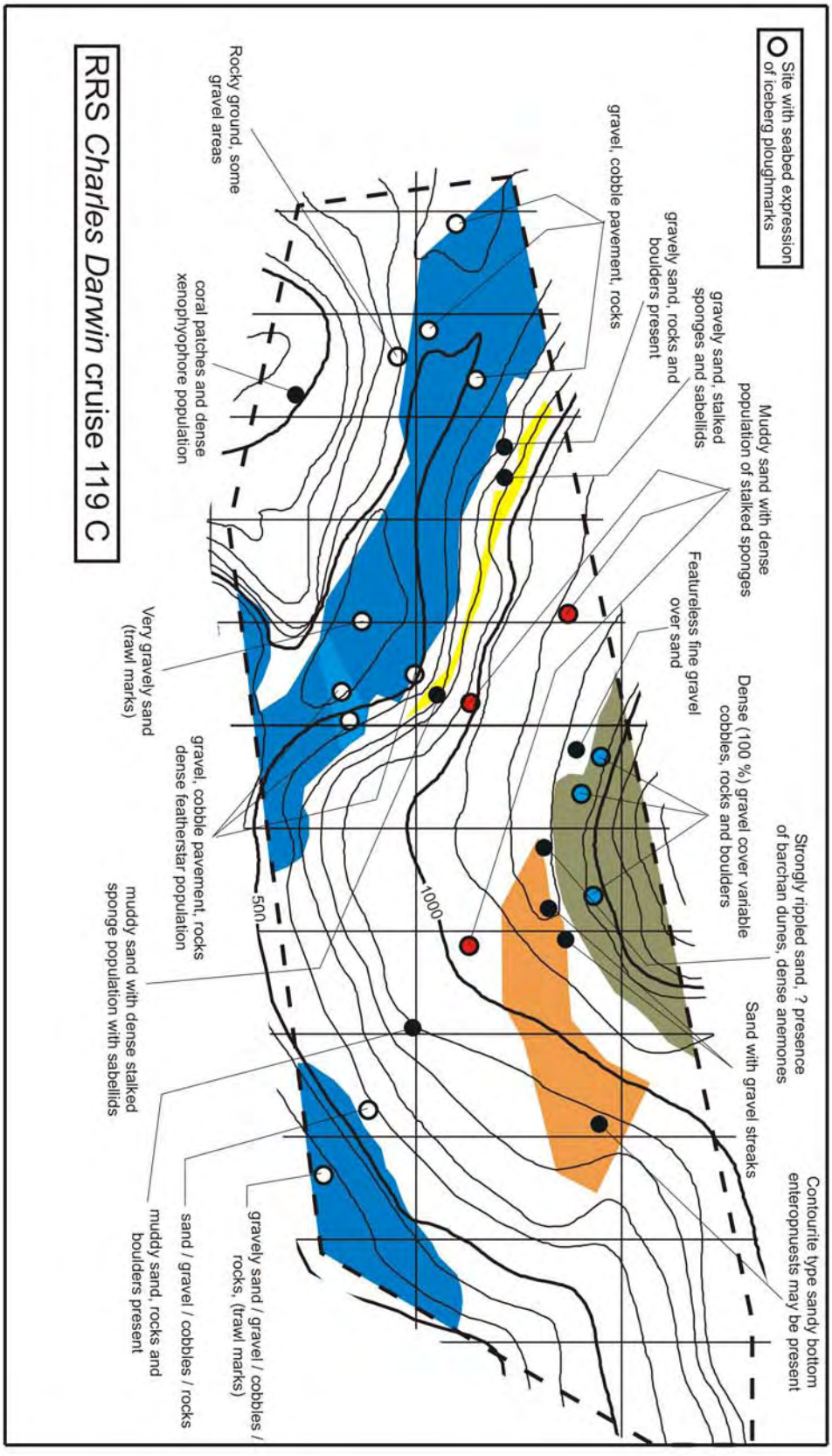

Figure 9. Seabed observations shown in relation to interpreted sidescan (see also figure 8)

Seabed expression of iceberg ploughmarking appears to be evident at (from west to east) sites W, E, B, FBC500, V, K, G2, G1, FSC500 and FSC300 (see figure 9). This is in very close agreement with the sidescan sonar data. These sites are not, however, uniform in relation to their respective faunas. Sites near the apex of the Wyville Thomson Ridge (W and V) have only a poorly developed encrusting fauna. Similarly sites on the eastern side of the Faroe-Shetland Channel (FSC500 and FSC300) have only a poorly developed encrusting fauna, as was also observed for the southern, west of Shetland area assessed during the AFEN 1996 survey (Bett, 2000). In contrast sites E, B and FBC500 have a well developed encrusting fauna, often of massive sponges. While sites K, G2 and G1 share the common development of extensive brittlestar carpets. Several of these sites have also apparently been influenced by fishing activity, trawl marks were recorded at sites V and FSC300, and cable, rope or net recorded at sites E and FBC500.

Below the iceberg ploughmark zone the two 800 m sites (FBC800 and FSC) appear to represent a transition from the rockier ground above to the more open sediment settings below. The contourite band on the lower (northern) slope of the Wyville Thomson Ridge (sites FBC1000 and J) at around 1,000 m appears to share a common fauna, jointly dominated by stalked sponges and sabellid polychaetes. At or a little below 1,000 m (sites FBC1200, L and FSC1000) this 'community' is modified to sole dominance by stalked sponges in these sandy areas.

Sites within or abutting the sand-related features area (see figure 3), FSC1200, R1, R2 and S, are rather heterogeneous with respect to seabed type, but all have little in the way of obvious fauna. The probable barchan dune field observed at site FSC1200 is the most interesting of these sites, and probably worthy of further study. The fauna here appears to be dominated by small anemones that inhabit what would appear to be the lee-side of the sand ripples.

In contrast to the latter sites, those sites located within the lineated gravel area (see figure 8), N1, P and Q are comparatively homogeneous, both with respect to the appearance of the seabed and the associated fauna. The presence of these deep-water gravel areas, with their relatively well developed sponge and featherstar populations, seems to suggest more active deep-water flows on this side of the channel, i.e. contrast with the sandy, stalked sponge dominated sites, FBC1200, L and FSC1000. The intermediate site, N2, with its fine gravel cover over sand is rather lacking in obvious fauna, being apparently unsuitable for the stalked sponges and lacking the stable hard substrates on which an encrusting fauna might develop.

Central Faroe-Shetland Channel

The four sites studied in the central Faroe-Shetland Channel (X1-3 and Y1, see figure 10) were all relatively heterogeneous with respect to seafloor type: gravely sand with cobbles and rocks, and indications of appreciable current flow. There was, however, some variation in faunal composition / dominance. The three lower slope sites, X1, X2 and Y1 were typically dominated by a mix of featherstars, octocorals and sponges; whereas the fauna of the channel floor site, X3, showed dominance by ophiuroids and cerianthids. This differentiation between the lower slope and channel floor settings is in agreement with the observations made during

the 1996 AFEN survey of the west of Shetland area (Bett, 2000).

The northern area

The sites in the northern survey area can be conveniently divided in to two groups based on their physiographic settings (figure 11): a) those on the Faroe Plateau Slope (sites FPS1000, FPS1500, FPN1100, FPN1400 and FPN2), and b) those that might be regarded as falling within the Norwegian Basin (sites NS1-4, FPN1800 and FPS1800).

The Faroe Plateau Slope sites are relatively heterogeneous with respect to both the seafloor type and certainly seabed fauna. The shallower sites (c. 1,000 m, FPS1000 and FPN2) are dominated by brisingiids. The deeper sites (FPS1500, FPN100 and FPN1400), though broadly similar in seafloor type, have dominance by ophiuroids in open sediment areas and sponge and octocoral dominance where hard substrata are available. This differentiation presumably reflects the bathymetric distributions of the dominant species. It is also worth noting that corresponding depths on the Shetland side of the channel, typically have rather less available hard substratum and consequently a rather different faunal composition (Bett, 2000).

In marked contrast to the heterogeneous slope sites, the Norwegian Basin sites are highly conservative with respect to seabed - a creamy deep-sea mud. Although these sites span an appreciable bathymetric range (1,470 - 2,275 m) their faunas appear to be quite similar (though note very high density of ophiuroids at site NS1). The obvious visible fauna at these sites is somewhat limited, however, the dominant lebenspurren are common to all sites: large open burrows (probably paired) and the tracks and feeding traces of asteroids, which typically remain buried.

Sites FPN1, NS2 and NS4 also share diapiric structures in common. Although these are rather impressive features, they do not appear to support any distinct fauna. The presence of ‘scree slopes’ and ‘rock filled gullies’ among these features does introduce otherwise rare hard substratum to the Norwegian Basin area, which consequently may modify the fauna to a limited extent. The diapiric features appear to be principally of geological rather than biological interest.

More generally, it is worth noting the general sedimentary setting and fauna of the Norwegian Basin area appears to be quite distinct from the contiguous area of the Faroe-Shetland Channel floor (as assessed during the 1996 and 1998 AFEN surveys; Bett, 1997 and 1999). This distinctiveness has also been detected among the macrobenthos populations of these two area (Bett, 2000). The most likely controls for this variations would seem to be linked changes in sediment type and water flow regimes, from the relative confines of the channel to the open basin.

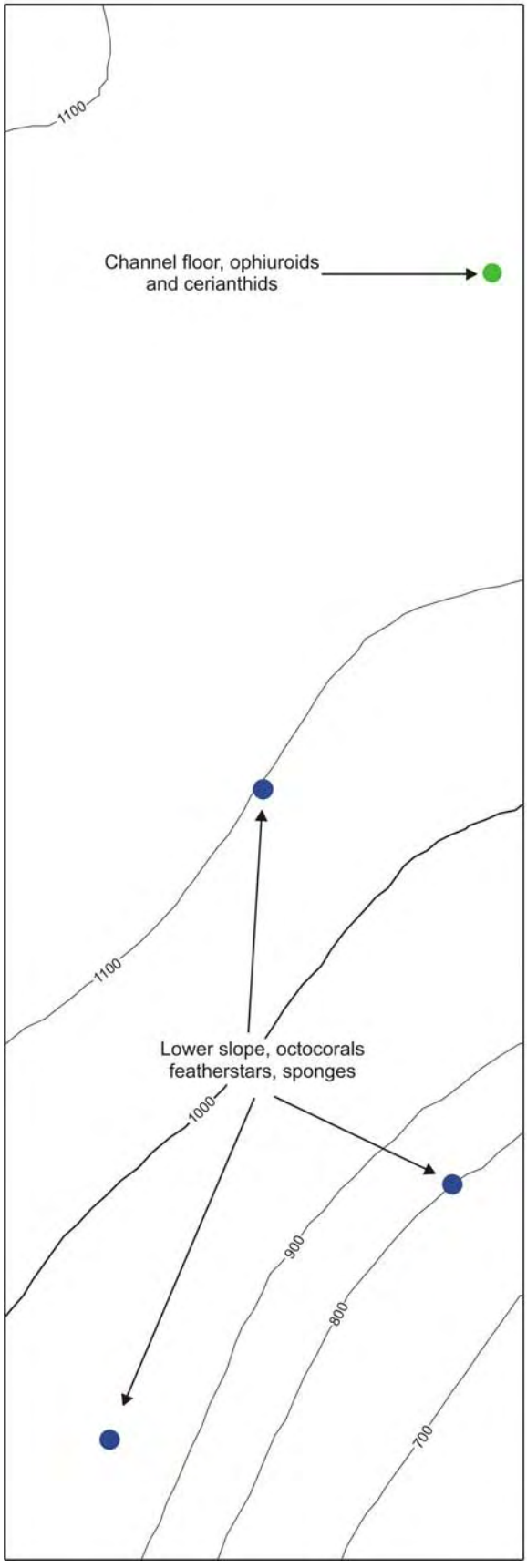

Figure 10. Seabed characterisation for the central Faroe-Shetland Channel area.

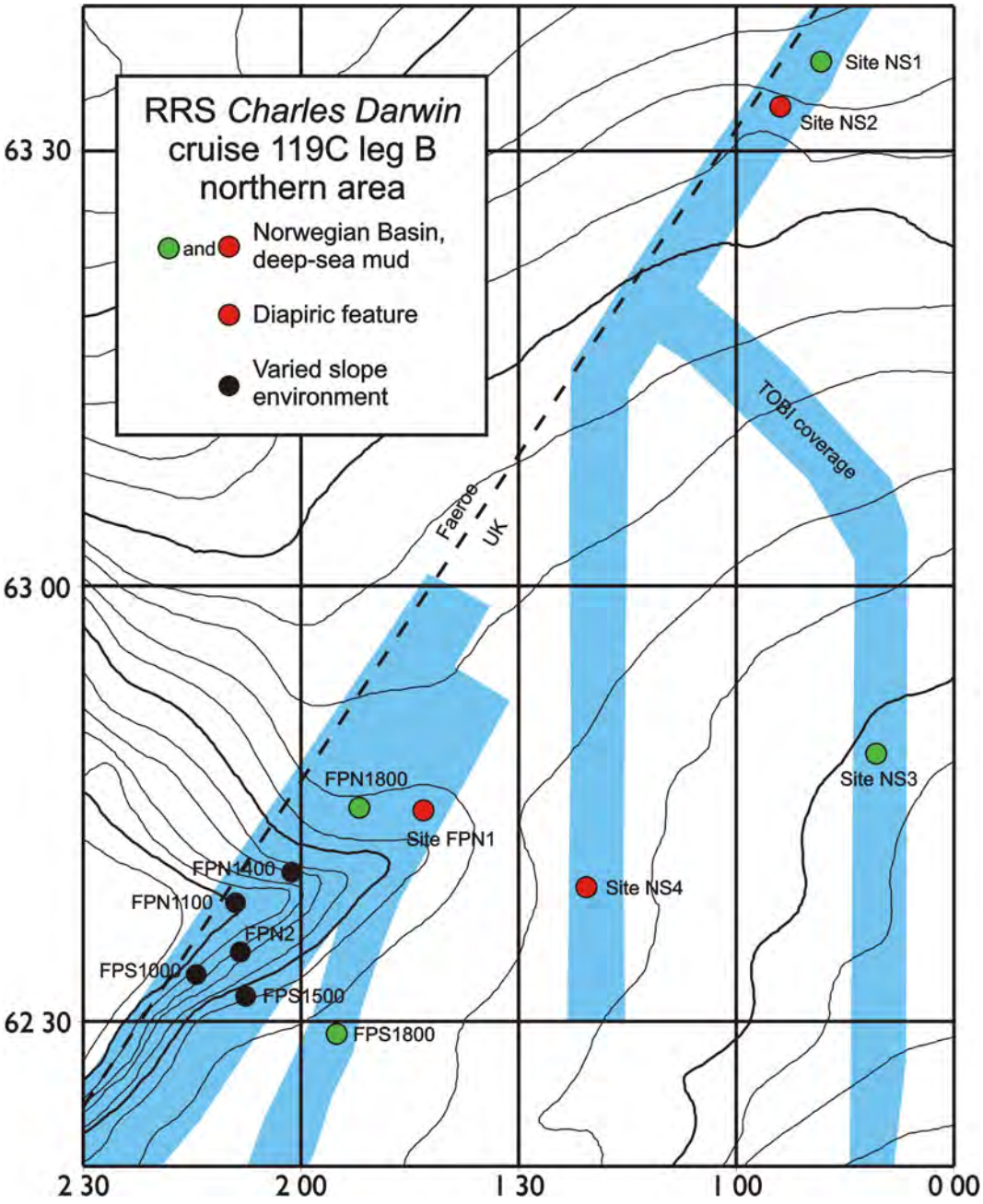

Figure 11. Seabed characterisation in the northern survey area.

13.4. Summary

The seabed area surveyed during the course of the White Zone (WhiZ) Environmental Survey encompasses a wide variety of environments. The distributions of biological communities present are undoubtedly controlled by a suite of factors, principal among which are likely to be: water depth, water mass characteristics, substratum type and physiographic setting. The results from the Faroe Bank Channel area provide a good example of depth related zonation in both seabed type and animal community. The contrasting nature of the seabeds and faunas of the northwest and southeast regions of this area, as well illustrated by the TOBI coverage, does, however, indicate the need for caution in extrapolating the results of the survey beyond its present boundaries.

Other highlights of the WhiZ seabed survey include:

a) the discovery of an additional field of *Darwin Mounds* (small 'tailed' sand volcanoes) with a unique zonation of corals and xenophyophores. Note that colonial hard corals were not observed at any other location during the survey.

b) the seabed observation of a barchan sand dune field, deep (1,150 m) in the Faroe-Shetland / Faroe Bank Channel.

c) the seabed observation of major diapiric structures in the Norwegian Basin.

13.5. References

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